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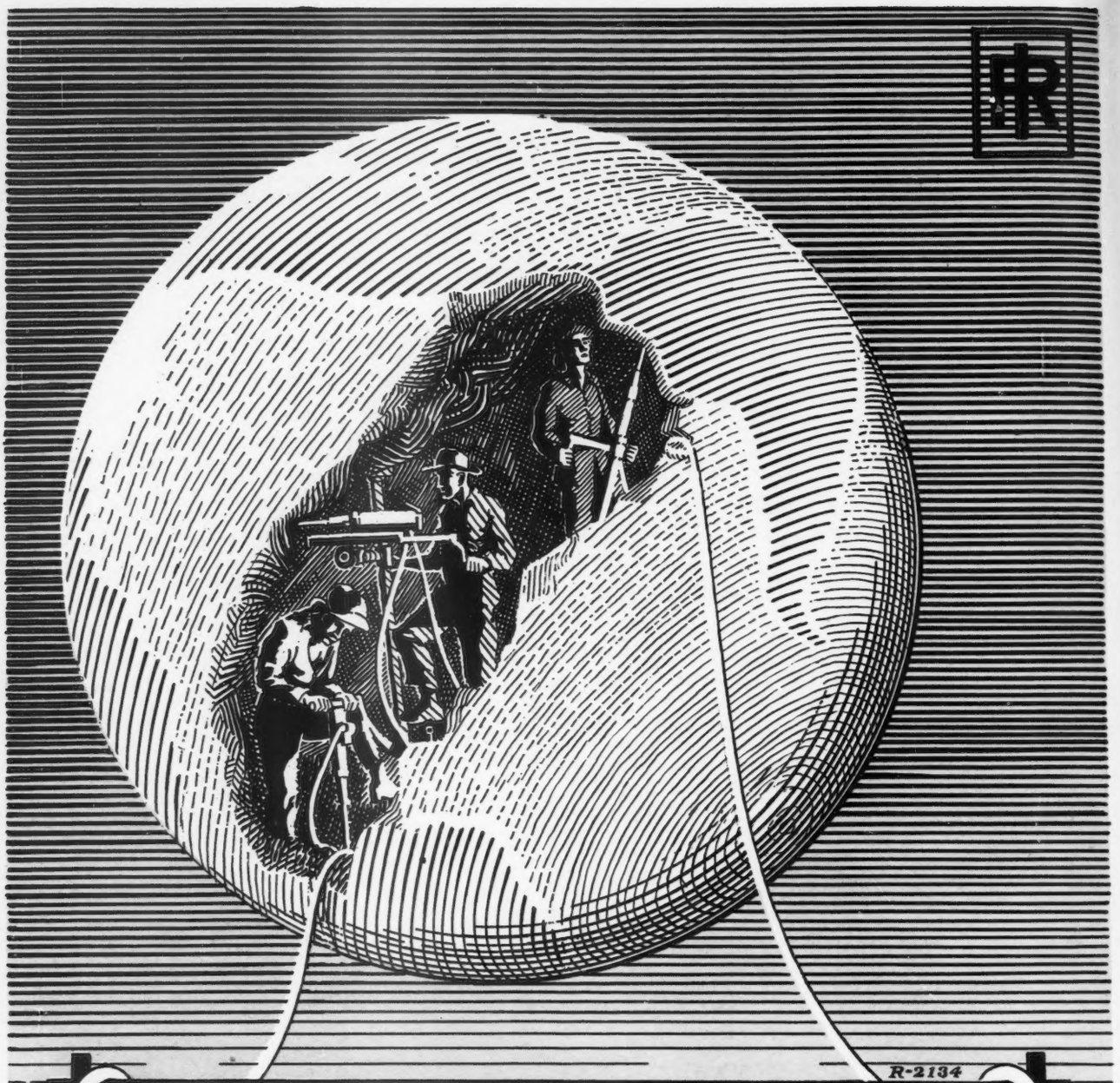
Underground hoist room at United Verde before concreting

December 23, 1930



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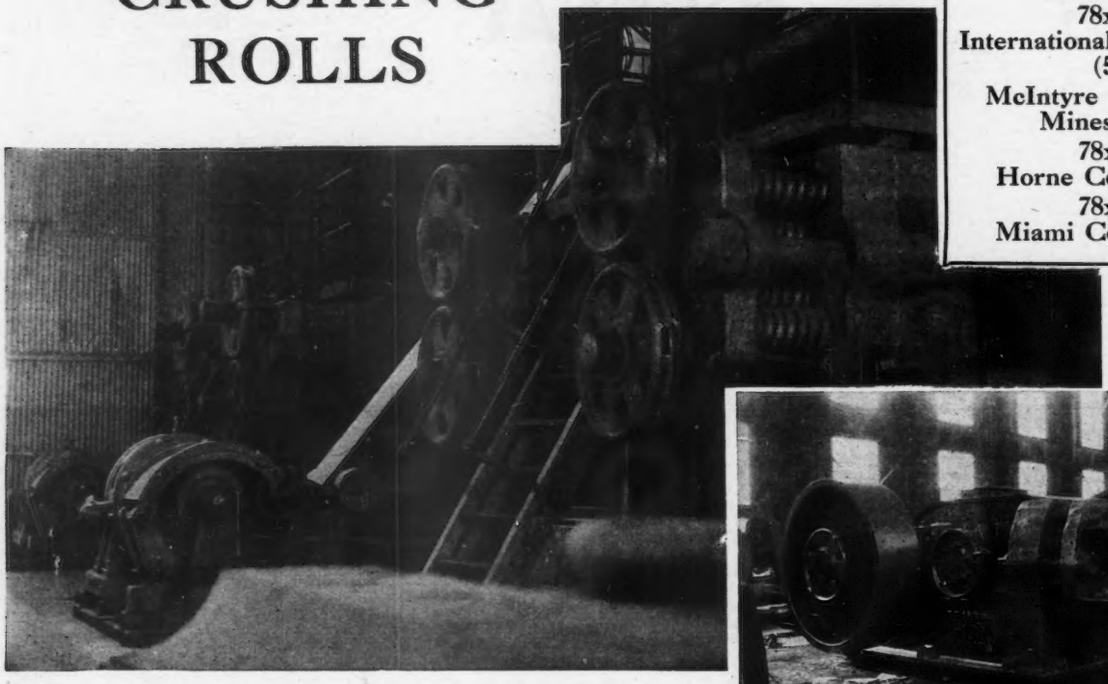

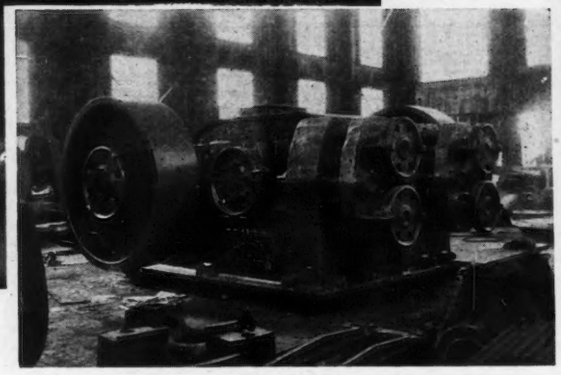

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A. W. ALLEN, *Editor*

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Adjusting Work Periods to Relieve Unemployment

UNEMPLOYMENT, an inevitable feature of industrial depression, is now a serious problem. Industrial officials regard it with mixed emotions. On the credit side they realize that it promotes the efficiency of the individual worker, who may work harder for fear of losing his job. Labor turnover is reduced for the same reason. An "employers' market" also permits the release of employees who have not been altogether satisfactory and the retention of the most desirable, thus raising personnel standards. On the other hand, a company may be forced to discharge some of its men because it cannot sell all of its output at a profitable price, and this is galling to any executive who, in the last few years particularly, has grown to depend on modern salesmanship technique, with constantly expanding business and larger profits. Furthermore, extensive unemployment obviously decreases the buying power of the general public, thus adding to the depression which has caused it.

Many means have been suggested to relieve unemployment. Socialists made the relief of the unemployed a platform in their recent political campaign, suggesting that the government should do something. The government, they argue, gave unproductive work for millions of men in the World War and should not throw up its hands now at the prospect of an unemployed army of little more than half that number.

Mr. Henry Ford has suggested the ten-month year. The United Textile Workers favor a thirty-hour week—five days of six hours each. Critics object to this solution. An editorial in the *Wall Street Journal,* for example, says that "one great objection to this idea, if put into practice, is the great danger that it would increase unemployment. This idea is apparently in disregard of the fact that wages must always be earned in order to assure employment. . . . If by working six hours a day for five days a week a man can produce as much as if he worked eight hours a day for six or even five and one-half days a week, then there would be a powerful argument for the thirty-hour week." This contention does not seem valid under existing conditions, for reduced production is what is needed to remedy the present situation. Many pressing problems arise from the circumstance that burdensome stocks are on hand. Production should be reduced until they are marketed. This applies particularly to the mining industries, as witness the situation in copper and zinc.

When copper production was curtailed a few months ago, some of the mining companies resorted to the five-day week, rather than a wholesale discharge of employees. A reduction of the working time would seem to be the best method to pursue for many industries. The public welfare would be better served by the provision of a job for every one who wishes to work, and is fitted to do so, for thirty hours a week, than by giving work for only a part of the wage-earning population for forty-eight hours a week. But the man who works only thirty hours a week cannot reasonably expect to get the same wages as if he worked longer. The hourly rate of payment might well remain the same for the present.

Eight hours of work per day is not arduous in most occupations. A shorter working week, or ten- or eleven-month year, would seem preferable to the six-hour day, though this is a matter on which public opinion should be sounded. The Ford idea of a ten-month year offers perhaps the best opportunity for the profitable use of spare time. The ordinary worker probably would not save enough in ten months to carry him over the two, when he might be without income, but this disadvantage might be remedied by deductions from the payroll during the year, to be paid during the layoff period.

The ten-month year, the five-day week, or the six-hour day should not be inflexible; when the demand requires it the hours should be extended to eight a day, to forty-four a week, or to eleven and a half months a year. These might be considered the maximum of productive activity, when demand is at its height. When the sales department is less successful, the work period should be reduced, but no faithful and competent employee should be discharged unless there is some reason other than lack of work for him to do.

Mining Trends and Changing Conditions

THE change in mining conditions is illustrated in the following quotation from the annual report of the Gold Fields Rhodesian Development Company:

"There has been a decided lull in prospecting, particularly during the last few months. As regards gold mines, it has been recognized for a long time past by those qualified to judge that only by the merest chance could the 'old-time' system of prospecting reveal further mines of size, and this has at last been realized by the Government, for, in conjunction with the British South Africa Company, they have adopted the system which has given such good results in Northern Rhodesia by, as a start, granting an exclusive prospecting right to a company known as the Victoria Prospecting Company,

Limited, of an area of 9,000 square miles in the Melsetter-Victoria districts, and the company referred to has been formed by several of the large mining houses. This company and other Rhodesian concerns have taken an interest therein. It is to be hoped that the scientific prospecting which will be adopted in dealing with the area will in due course bring to light some promising mines, which are so badly needed in Rhodesia if she is to continue to keep her place in the mining world. The world-wide depression in base metals has, of course, been reflected in prospecting; the activity in this section which has been in evidence for a considerable time past has received a considerable check and prospectors are finding great difficulty in disposing of the properties they have discovered."

The point of view advanced in the foregoing quotation coincides with that of many mining engineers who hold that older methods once successful must be supplanted by more modern practice, such as the granting of exclusive prospecting rights to large areas and to experienced mining companies backed by substantial resources. To take advantage of so-called scientific prospecting apparently requires capital and organization. To insure freedom from interference, prospecting rights to definite areas are considered necessary. At any rate, such prospecting rights make the problem more specific, and may be expected to insure a more thorough search of given areas than would otherwise be possible.

The last sentence in the first paragraph of the quotation will find sympathetic acceptance by Western mining regions in the United States, where a similar struggle to retain mining prestige is proceeding. Probably no other mining district illustrates this better than Tonopah, Nev. The rapid exploration and mining of the ore deposits resulting from the availability of capital, mining equipment, and metallurgical knowledge have several times threatened the existence of this noteworthy camp, but each lode was followed persistently. New ore was discovered and production continues. Only recently the discovery of a rich oreshoot in the heart of the supposedly worked-out Mizpah area created excitement. Mr. Thomas B. Nolan, of the United States Geological Survey, is completing a thorough study of the underground geology of the district, and in his preliminary statement presents the following conclusion:

"The geologic relations disclosed by the re-survey of the Tonopah district would appear to warrant continued exploration whenever economic conditions are favorable. The work has shown clearly that ore deposition occurred relatively late in the geologic history, and that, as a result, ore may be found in several geologic formations rather than being limited to one. If future exploration is based upon the several factors that appear to have controlled ore deposition, it seems probable that such exploration will be rewarded by new discoveries of ore."

Mr. Frederick W. Bradley a short time ago began an active campaign of exploration in the old Bodie camp, in California, practically dormant for many years, and as a result of reopening old shafts and both underground and surface work is preparing to begin a milling campaign. The old Standard mill is being rehabilitated and a new mill is being constructed. At the Bunker Hill mine, near Kellogg, exploration work in the upper levels has disclosed important lead orebodies, which are now being cut at successively lower levels. A considerable addition has been made to the large ore reserves, and the complicated structure underground is now better understood.

Two important trends thus dominate mining activities. One, illustrated by the Rhodesian example, has to do with new areas, and the other with the extensions of known districts as well as a thorough reworking of already mined portions. Both of these trends incorporate the aid of the geologist and modern facilities. Both also are under the tutelage of experienced miners and financially able companies. Both hold promise of successful and beneficent achievement.

Metallurgical Perfection Not Yet Reached

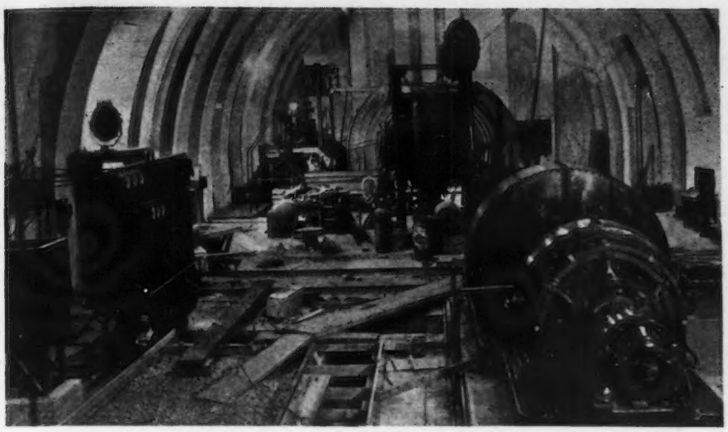
A CONTRIBUTOR calls attention to the losses in copper, nickel, sulphur, and iron in concentrating and smelting the Sudbury ore. The copper and nickel losses, of course, are small compared to what is recovered, even though they do bulk fairly large when considered by themselves. Just how large they should be is, of course, an economic question. A concentration or smelter recovery of better than 99 per cent could be made at many copper plants, but it would not pay to do it. It would involve more grinding, classification, tabling, conditioning, and flotation treatment than the recovered copper would be worth.

Metallurgists have much to be proud of. Twenty years ago Utah Copper put about 40 per cent of its copper on the tailing pile; last year, less than 15 per cent. But even 15 per cent meant a loss of over 70 tons of copper, or more than $25,000, per day. On a given grade of ore the copper lost in tailing or slag will gradually become less as metallurgical methods improve, but the march of progress will not carry us as far in the next twenty years as it did in the last twenty. That is, unless some of the miracle workers we occasionally hear about succeed in getting more copper out of an ore than there is in it!

But our correspondent's remarks about iron and sulphur losses refer to a subject about which metallurgists will before long begin worrying. One may hazard a guess that 90 per cent of the sulphur and iron from smelters will be recovered fifty years hence. All of the iron is now discarded, and most of the sulphur, because it costs more to recover them than they are worth. At one plant in Canada the sulphur going up the stack is believed to be more than three times as much as the total sulphur imported into the country; and the iron going to the dump amounts to more than twice the iron in imported ore. These same immense losses of iron and sulphur occur at every copper smelter in the world, except in the unusual case, as in Tennessee, where copper sulphide ores are smelted as much for the acid that can be made from them as for the copper they contain.

While on the subject one may as well confess to all inefficiencies of prevailing methods, and consider the vast amount of heat lost on a slag dump as well. At 1,200 deg. C., a ton of slag poured on the dump contains about 2,600,000 B.t.u., equivalent to the latent heat in 200 pounds of coal. In time a low-pressure turbine, or something of the sort, may be developed to utilize this heat at a profit. Many schemes have been proposed, and the problems enumerated afford fascinating and useful opportunities for research and experimentation.

Underground Hoisting Plant Transfer and Erection



The new hoist room at No. 5 shaft, when the installation of equipment was practically completed

C. E. Mills

Assistant Mine Superintendent, United Verde Copper Company, Jerome, Ariz.

AN EXPLANATION of the need for constructing a new underground hoist room for the present ore shaft of the United Verde Copper Company, at Jerome, Ariz., will be found in the following description of the existing conditions: This shaft (No. 5) is used exclusively for hoisting rock, and extends from the sheave room on the 800 level to the lowest, or 3,000-ft., level. It is lined with reinforced concrete and has two 5x5-ft. hoisting compartments and one 5x5-ft. manway and pipe compartment. The old hoist room is on the 1,000 level, to the east or hanging-wall side of the shaft, as shown in Fig. 1. It is 47x81 ft. in section, 22 ft. high, and is lined with reinforced concrete. Although the shaft is in the porphyry footwall, the hoist room is on a main iron-schist contact, and a small amount of movement has been noticeable during the past four or five years. This movement was sufficient to cause failure of the concrete lining in the hoist room, and resulted in constant attention to both hoist and generator bearings.

Mining at greater depths may involve some ground movement in the upper portion of No. 5 shaft and also in No. 6 shaft. The mechanical equipment of the latter shaft is limited in depth to the present bottom level. These conditions justified a new shaft program for greater depth, and a new combined service and ore shaft (No. 7) was planned in 1928. Crosscuts were started to the new shaft location on each level in October, 1929.

To insure continuous operation of No. 5 shaft until the new shaft is completed, and to assure to it several additional years of life, it was deemed advisable to construct a new hoist room on the footwall side of the shaft and to drive new cableways to the present sheave room, as shown in Fig. 1.

During normal operations it was inadvisable to stop underground production, which would have been required in order to move the old hoist.

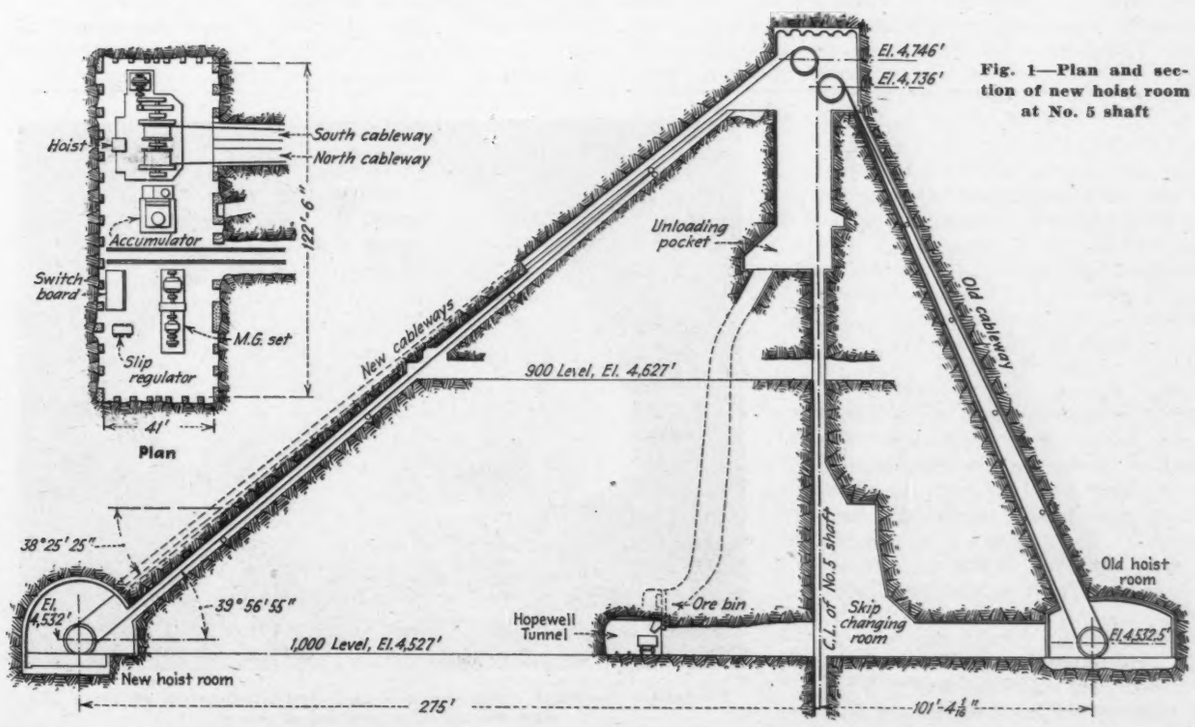


Fig. 1—Plan and section of new hoist room at No. 5 shaft

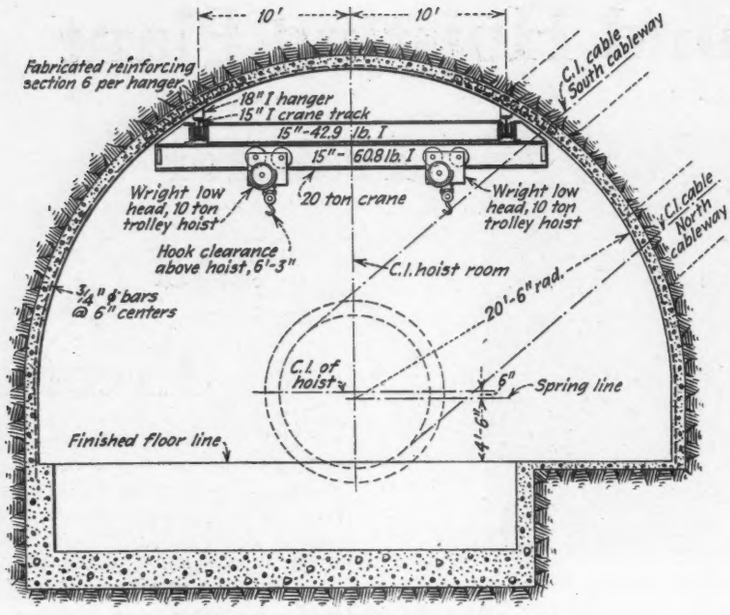


Fig. 2—Crane installation in hoist room

Consequently, a new hoist was purchased which could be moved later to the surface for use in the new shaft. The new hoist, of Nordberg make with Westinghouse electrical equipment, was designed to lift 8-ton skips at a speed of 2,500 ft. per minute from a depth of 5,000 ft. Its drums are 12 ft. in diameter, with a 7-ft. face. The hoist will be direct-connected to a 2,700-hp., 550-volt, 66-r.p.m., d.c. motor. The flywheel set consists of a 2,800-hp., 6,600-volt induction motor and two 1,250-kw., 55-50 volt generators. Designed to take this hoist, work on the new hoist room was started in April, 1929. The room was practically completed, except the foundations, in June, 1930, when a curtailment of underground operations permitted the resulting limited underground tonnage to be caged through No. 6 shaft, and No. 5 shaft to shut down for a sufficient period to move the old No. 5 hoist into the new hoist room, thereby saving the cost of installing and later moving the new hoist to No. 7 shaft.

Development work necessitated by the new plans was as follows: Drifting consisted of a connection to the present main haulage tunnel; also 145 ft. of drifting within the hoist room to facilitate the raising of the cableways, and 130 ft. of drifting on the 900 level to give access to the cableways. The tunnel connection on the 1,000 level is 235 ft. long and 9x12 ft. in cross-section, and is in moderately hard porphyry. The contract price was $6 per foot, including explosives. Mucking was done with a Nordberg-Butler shovel.

The cableways were raised from drifts driven within the limits of the hoist room, and also from the 900 level. The raises at the hoist room were 5 ft. by 8 ft. 6 in. in cross-section, with a 4-ft. pillar between. Convergence of the cables as they approached the sheave position brought the raises together about 45 ft. above the 900 level and the upper 95 ft. was driven as one opening, 5 by 12 ft. in section. Contract price for the cableway raises was $5.25 per foot, including explosives. The inclination was approximately 39 deg., so that the muck had to be pulled down with a small double-drum slushing hoist and scraper. An allowance of $0.50 per foot was made for mucking and pulling the chutes. The manway was carried by keeping temporary stulls lagged to sufficient height to keep out the muck. An allowance of $1 per foot was made for timbering. Upon completion, the cableways were given two coats of Gunite to prevent slabbing.

The hoist room excavation was 43x124 ft. in area, and was cut 26 ft. in over-all height with a radius of 21 ft. 6 in. and spring line 4 ft. 6 in. above finished floor line. In making the excavation, the first cut was taken 9 ft. in height and on the sill. The next two successive cuts were made with flat holes similar to breast stoping, working on the broken muck pile. Placing of the holes was watched carefully to minimize overbreak, and, where close to the walls, the collars of the holes were located and the depths determined before drilling. Average overbreak on the walls was 9 in.

Contract price for silling was $0.75 per cubic yard for mining and explosives, and the price for stoping and trimming to line was $0.70 per cubic yard. Foundation pits and ducts below floor line were paid for at the rate of $3.50 per cubic yard. The ground was fairly hard quartz porphyry, permitting an average drilling speed of 14 in. It was also badly fractured and broke in large pieces, so that the speed of mining was determined by the mucking. Three to four miners worked on two shifts, and eight to twelve

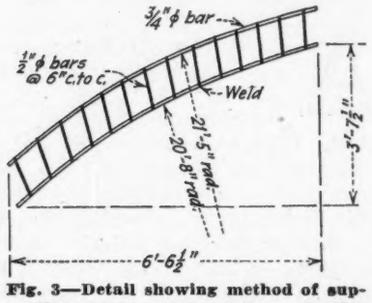
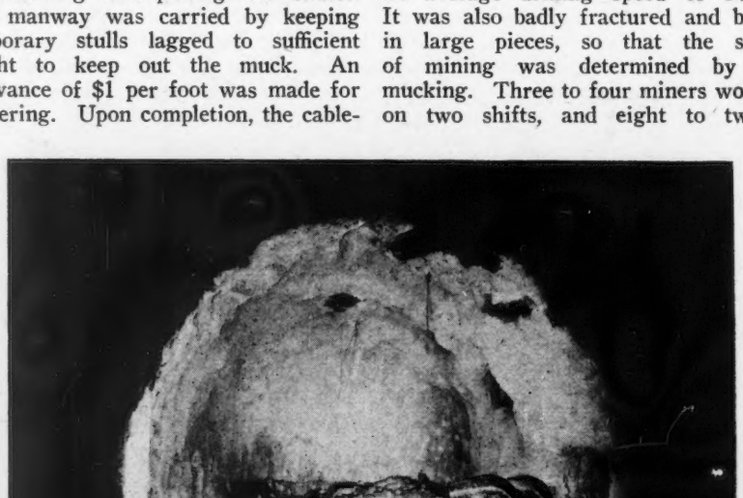
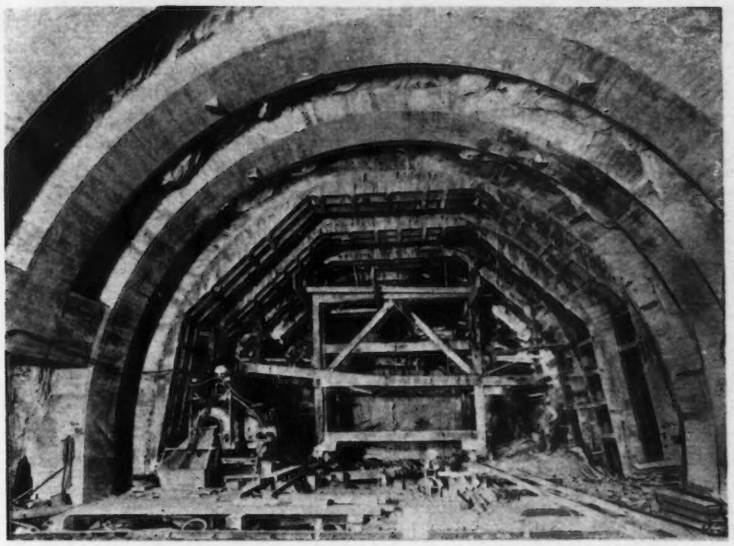


Fig. 3—Detail showing method of supporting crane track girder. Section through ring.



Excavation completed above the floor line. Hoist foundation pit being dug, with the aid of a mechanical shovel.



The blocky rock walls of the hoist room excavation were supported with concrete ribs

muckers on three shifts. The cars used were 20-cu.ft. scoop cars with sides built up to give 30 cu.ft. capacity. The length of tram averaged 240 ft.

Excavation above the floor line totaled 4,500 cu.yd., and the foundation pits and ducts approximately 750 cu.yd. Most of the mucking was done with Nordberg-Butler shovels, which speeded up the work considerably. The cost per cubic yard for mechanical mucking was as follows: Labor, $1.32; repairs, $0.24; depreciation, $0.16; total, $1.72 per cubic yard in place. Depreciation is based on a two-year life with an original cost of $2,580 for the Nordberg shovel. No charge is made for compressed air. Although as high as 60 cars per shovel shift was not unusual, the average was but 34.1 cars, or 12.6 cu.yd. in place, because of the coarse size of the rock and the slower speed made when mucking below floor line. The foregoing cost of $1.72 per cubic yard compares with a hand-mucking cost of $1.31 per cubic yard in drift work. The total cost of the excavation was $14,577, not including the 145 ft. of drifting within the hoist room, or a unit cost of $3.20 per cubic yard of rock in place.

In the completed excavation the rock walls were strong but rather blocky, and required some support to prevent loose slabs from spalling off. This condition is shown in one of the illustrations. It was also desirable to have sufficient concrete to support the crane girders for handling the mechanical equipment. The ring or rib method was therefore chosen, the ribs being 3 ft. 6 in. wide with 4 ft. 5 in. spaces between.

The forms and method of supporting them are shown in one of the accompanying photographs. Sectionalized forms consisted of five segments made of three 2x12-in. planks cut to the proper radius and sheathed with 1x4-in. strips. They were set in place and braced to the traveling frame or carriage, which served as a working platform and permitted two rings to be formed at one time. Reinforcing consisted of ¾-in. bars at 6-in. centers and special reinforcing was built up in cages to support the crane hangers. The design of the special reinforcing is shown in Fig. 2. The sides of the forms were sheathed to the wall with 1x6-in. native pine and braced where the depth of concrete was over 12 in.

Aggregate was delivered in standard-gage 40-ton mine cars to the room. Two cars were used for the transportation of sand and gravel, and small slide gates were cut into the inclined car doors to deliver direct into wheelbarrows. A 1:2:4 mix was used and discharged from the mixer into a small bucket by gravity. The bucket was elevated by means of an Anaconda-type air hoist and the concrete poured by gravity into the forms through movable troughs. The upper portion of the forms which could not be filled by gravity were concreted by the use of a small compressed-air gun which handled one-half of a batch at a time.

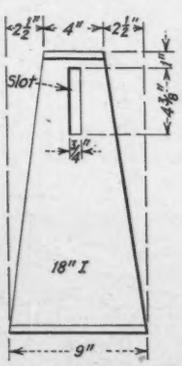


Fig. 4 — The 18-in. I-beam hanger

Concreting was done on three shifts with crews of six to eight men. The average time for the sixteen rings, including the end wall ribs, was five shifts per ring for setting forms, pouring, moving, and trimming walls. The contract price for labor required for forms and pouring was $15 per cubic yard. Total yardage in the sixteen rings and end ribs was 316 cu.yd., and required 28 working days to complete. The intervening rock space was later given two coats of Gunite to prevent air slacking or spalling. Foundations and trenches required 630 cu.yd. of concrete of a 1:3:5 mix. Several carloads of clean diorite "plums" were used in the massive foundations. The labor contract price for forms and for placing concrete was $3.80 per cubic yard. Total cost for concreting, including rings, foundations, trenches, Guniting, painting, and other miscallaneous items, was $34,919, or $36.90 per cubic yard of concrete.

For installation and repairs the hoist room is equipped with a hand-operated crane of 20-ton capacity with two 10-ton low-head type chain blocks. The cost of this crane was $1,994, or about one-third of the cost of an electric crane, and required much less headroom, which is an important factor in underground construction. The method of supporting the crane girders is shown in Fig. 3. This crane installation proved quite satisfactory in installing the hoist and handled up to 25 tons without difficulty. Rope idlers are 28 in. in diameter and spaced at 70 ft. intervals. Idlers and stands were made up in the company foundry and shops. Brass bushings were used in the hubs in preference to roller bearings.

The sheaves at the 800 level are 10 ft. in diameter, and are of ½-in. plate-type construction and equipped with steel liners. The existing sheave room was of sufficient size to permit the sheaves to be installed on the opposite side. Necessary new steel work for supporting the sheaves had been erected before moving the hoist without interference to operations, and the sheaves were moved while the hoist transfer was being effected.

No. 5 hoist was installed in 1919. It is an Allis-Chalmers, double-drum, single-reduction, geared-type hoist, driven by a Westinghouse 650-hp., d.c. motor, with current at 550 volts and a normal speed of 500 r.p.m. Drums are 10 ft. in diameter with a 5-ft. face and a capacity of 2,500 ft. of 1⅛ in., 6x19 hoisting cable in two layers. Rope speed is 1,000 ft. per minute. The flywheel generator set consists of a 750-hp., wound-rotor induction motor, one 600-kw., 500-volt, d.c. generator, and a 10-kw. 250-volt exciter. The flywheel is 7 ft. 6 in. in diameter and weighs 20 tons. The total weight of the various mechan-

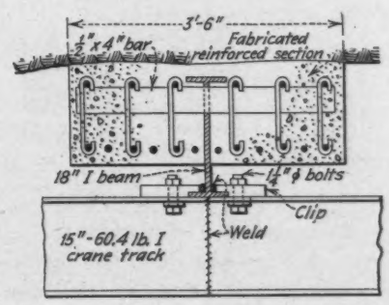


Fig. 5—Detail of the fabricated section

ical parts of the hoist is 271,000 pounds.

The old hoist room was equipped with a 20-ton hand-operated crane, but the ground movement limited the use of it to lifting the generator set. A 24-in. I-beam was placed across the hoist room on top of the crane girders and fastened with clips to permit it to be moved. Two 10-ton chain blocks with trolleys permitted the various pieces of equipment to be picked up and moved over the track leading into the hoist room. This beam and its trolleys were limited in lateral movement and the greater portion of the hoist, including the hoist motor and generator set, had to be moved on rollers and cribbing or temporary trackwork to a point opposite the entrance to the room and either picked up with the temporary crane or skidded on to standard-gage steel cars. After the various pieces were once loaded, it was a comparatively simple matter to push the cars over to the new hoist room where the crane served the entire hoist room. The rigging and handling of the heavier parts of the hoist out of the old hoist room was facilitated by the use of two air hoists with drums and niggerheads, these being used to move the trolleys on the beam and heavy parts on rollers.

Because of the amount of exploration and shaft development done, the storage for waste underground was limited to approximately 45 days. It was therefore necessary to move the hoist and have it running within that time. For this reason the moving was carried out on a three-shift basis. The crews consisted of eight machinists, eight helpers, six electricians, with six helpers, twenty miners used as roustabouts, and a crew of surface roustabouts when needed. Each shift was handled by a boss under the supervision of the master mechanic, and each crew of electricians and machinists had a working jigger.

The hoist was shut down Aug. 25, 1930, and was again running on Sept. 22, or a total of 28 days. It was stripped to the bed plate in four days, and at the end of the first week the bed plate was reset in the new hoist room and the bearings were ready for alignment. Four days were spent in lining and scraping in new bearings, and from then on the work progressed rapidly. An 18-in. shop lathe was set up in the hoist room for making pins and bolts which required replacing.

The number of man-shifts per day averaged 47.5. Average wage was $5.43, making a total labor cost of $7,234. The bonus standard set was 45 days, and the bonus made in finishing the job under the limit set was 45.5 per cent, in addition to day's pay. This does not include preparatory work, nor finishing up after the hoist was in operation. The total cost of the moving job will be approximately $14,000. The illustration on the first page of this article shows the hoist room when the hoist installation was about completed.

■ ■ ■

Ingenious Portable Machine for Undercutting Motor Mica Segments

KEEPING a motor commutator in good condition insures perfect commutation and a smooth running motor, seldom subject to overheating. To accomplish this, a periodical reconditioning of the commutator surface in the lathe, with a subsequent undercutting of the mica segments, is necessary. The lathe work is relatively simple, whereas the undercutting, when performed manually, requires considerable time and skill to make it a neat appearing job.

Charles R. Clarkson, master mechanic at the American Smelting & Refining Company's smelter at Hayden, Ariz., conceived the idea that this operation could be performed mechanically, and accordingly built the ingenious portable machine shown in the accompanying sketch. The machine consists of a sturdy truck, made of 4-in. channel iron; two adjustable telescope-like supports, equipped with welded-on holders, made of 2-in. angle iron, accommodating the live and dead centers between which rests the rotor and commutator to be reconditioned; and the cutting unit, which resembles a shaper. Channel irons, with corresponding babbitt guides, are used exclusively for the construction of the ram, ram guide, and support, as shown in detail in Fig. 2. To relieve the weight resting on the two centers, which mainly serve to align the rotor, carefully machined supports are attached to the end of each movable section of the stationary pipe support. The ram is operated with a simple lever arrangement, as shown in Fig. 3, and a series of evenly spaced holes, provided on the ram guide, facilitate the adjusting of the ram stroke. Old hacksaw blades were found to be excellent material for making the cutting tools.

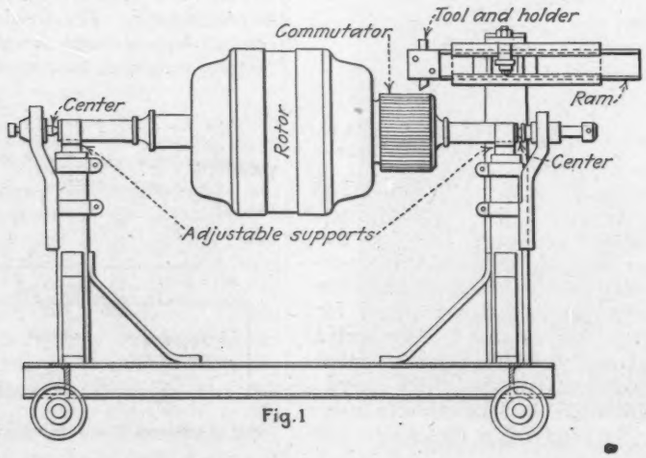


Fig. 1

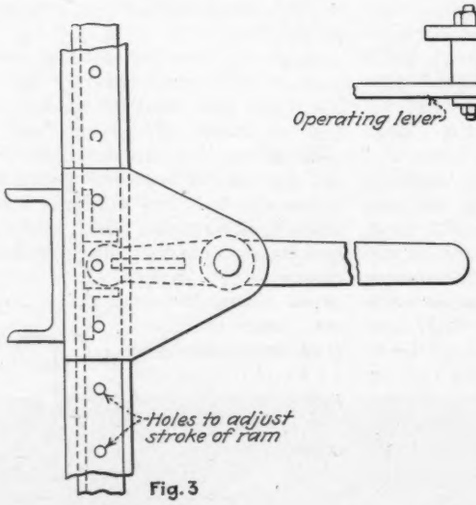


Fig. 3

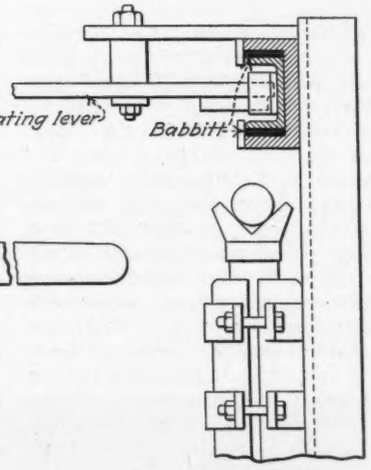
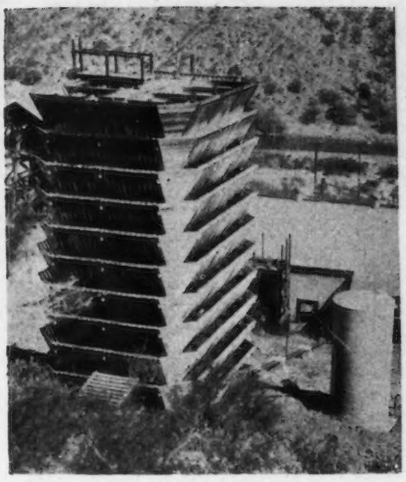


Fig. 2

Diesel Engines in Mining



Cooling tower of engine water-cooling system

Equipment and Operation of New Power Plant of the Christmas Copper Company

J. B. Huttl

Assistant Editor, Tucson, Ariz.

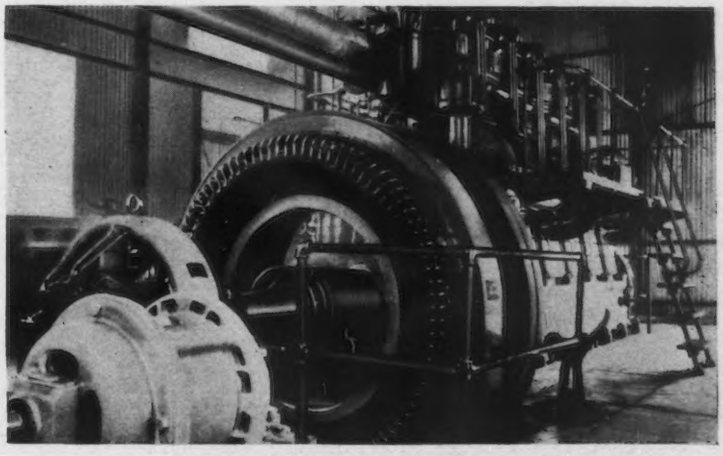
TO OBTAIN reliable service and economies in operation, no efforts were spared by the Christmas Copper Company in the erection of its new Diesel power plant at Christmas, Ariz.—one of the major developments of the company's program of expansion and modernization. Because of the amount of power used, and the assurance that the ore reserves would permit mining for many years to come, it was believed that power could be produced for substantially less with a well-designed power plant than if purchased. Accordingly, a careful survey was undertaken early in 1929 to determine what equipment was most desirable to meet successfully the prevailing conditions as to locality, water supply, load, and transportation. The selection of Diesel engines took into consideration the remoteness of the property, limited ground space available, and unfavorable water conditions. The water, with an average of 35 grains of hardness to the gallon, is most unsuitable for steam operations. An additional important factor, seldom taken into consideration, is the uneven load imposed upon the power plant of a mining property. The selection, therefore, of four 450-hp. instead of two 900-hp. engines affords greater flexibility, and indicates foresight and knowledge, because apparent economies on floor space and lower purchase price of two large units are outbalanced by the savings effected on fuel and lubricating oil and maintenance costs with the four-unit plant. At plants with multiple units, one or two engines are always available after the peak-load period to permit repairs at leisure, instead of rush jobs with consequent increased repair costs; furthermore, the operating cost of a larger Diesel unit, when running at half capacity, is much higher than that of a smaller engine at full load.

As to the skeptical attitude taken some years ago—in some quarters even today—regarding performance and dependability of the Diesel engine for power generation, it may be said that improved design, better knowledge of materials and lubrication, based on elaborate research, have solved the operating problems experienced with the early Diesel engine. The modern product is equal—for remote localities it is even superior—to that of the steam or gas engine or turbine.

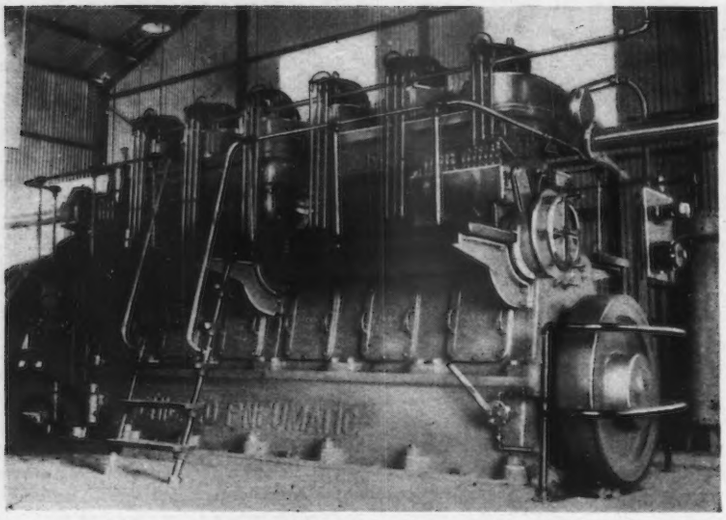
The new power plant, built in May, 1929, is at Christmas, Ariz., on the banks of the Gila River, adjacent to the ore-loading station and about 2 miles from the mine and mill, at an elevation of 2,150 ft. Its proximity to the railroad tracks and water source has lowered transportation costs for materials and oil to a minimum, in addition to avoiding the outlay for an elaborate pump and pipe installation. The four Chicago Pneumatic Diesel engines, three of which were installed in June, 1929, and the fourth of which was installed in April, 1930, with the necessary auxiliary machinery and water-softening plant, are housed in a large steel-frame structure covered with corrugated iron and equipped with large windows and roof ventilators. The roof trusses, equipped with Yale trolleys and chain blocks and spaced according to the center line of each engine, replace a traveling crane otherwise needed to facilitate repair work. To reduce vibration to a minimum, all concrete engine foundations are carefully insulated from the enameled cement floor.

Each engine, rating 450 hp. at sea level, is directly connected to a General Electric 300-kw., a.c., 3-phase, 60-cycle, 2,300-volt generator, and a General Electric, d.c., 12-kw., 125-volt exciter. The six cylinders operate on the full Diesel solid injection principle. With a bore of 14 in. and stroke of 21 in., each cylinder is capable of developing 75 hp. at 257 r.p.m. Individual adjustable injection pumps insure an even distribution of fuel to each cylinder. The average load per engine, 208.33 kw., is increased to 272 kw. during peak-load periods, representing a machine-load factor of 76 per cent at the elevation of 2,150 ft. With an average of 625 kw. to 900 kw., peak load, the plant factor is about 69.4 per cent.

The installation of Mid-Western air



Generator end of Diesel engine unit



One of the 450-hp. Diesel engines

filters on the headers connected to the intake manifold has solved the dust problem and lowered repair costs, the power plant being situated close to the main highway. All filters are periodically removed and washed in a solution of soft water and sal soda, with an after-treatment with viscosine. The exhaust manifolds and cylinder heads, of cast iron and fitted with inserted steel tubes to accommodate the cylinder stud bolts, are water-cooled. Because of the arid climate and rapid evaporation, the consumption of cooling water is correspondingly high, an average of about 8,000 gal. of make-up water being required every 24 hours. All exhaust pipes leading from the manifolds to the cast-iron washerless exhaust mufflers, from the engine to the engine room wall, are insulated with asbestos covering.

Of particular interest is the lubricating system, because of its simplicity and flexibility. Forced-feed lubrication is employed for bearings, and timed-forced lubrication for pistons. From the sump the oil pump of each engine, operated from the main crankshaft, draws and forces the oil in a continuous cycle at 25-lb. pressure through the corresponding machine parts to be oiled, and then returns it to the tank, or sump, for cooling and filtration. A 17-H DeLaval horizontal oil clarifier is operated in closed circuit with the lubricating cycle, which every 24 hours removes about 1 lb. of residue, containing, mainly, carbon associated with some heavy oil, silica, and iron oxide. As a safety measure, a Deming hand pump in the oil line is operated for a short period before the engine is started, to obtain sufficient oil pressure and correct lubrication. For lubrication, D.T.E. extra heavy oil is used exclusively, the consumption amounting to 1 gal. per 2,000 kw.-hr.

The fuel storage consists of three 15,000-gal. interconnected, corrugated, galvanized-iron tanks alongside the railroad tracks, and a 500-gal. day tank below the engine room floor. Because of the all-year mild climate, the heating of oil is unnecessary. For transferring fuel oil from the tank car to the storage tanks and day tank, small motor-driven Viking pumps are used. To insure a steady oil supply, the pump employed for conveying the oil from the storage tank to the day tank is equipped with an automatic float-switch control. From this point the plunger fuel pump, operated from the camshaft of each engine, feeds the oil evenly to a 5-gal. header tank, to which the suction pipes of the six fuel-injection pumps are connected. These pumps are fitted with special bypasses, through which unconsumed oil is returned by gravity to the day tank. All fuel oil is first filtered in Zenith duplex fuel-oil filters before reaching the injection pumps. The composition, heating value, and cost per gallon of oil, as furnished by the Standard Oil Company of California, is given in Table I.

Four 18x69-in. starting bottles, containing sufficient compressed air at 400-lb. pressure to start two engines without being recharged, and two $4\frac{1}{2}$x2x$4\frac{1}{2}$-in. Gardner-Rix two-stage compressors, comprise the starting equipment. Compressor No. 1 is motor-driven; No. 2, the stand-by unit, is connected to a New Way air-cooled gasoline engine, to insure operations in the event of a power cut-off.

One of the most important requirements for successful operation of a Diesel-engine plant is an adequate supply of suitable cooling water, together with a properly designed cooling system. This detail has been carefully considered at this plant. The cooling water is obtained from two deep wells, about an eighth of a mile distant from the power house. Air lifts, built on the principle of those employed in the oil fields, discharge the water into a large concrete sump. The necessary air for this operation is furnished by an I-R Imperial, Type 20, 50-cu.ft. compressor, direct-connected to a 15-hp. Westinghouse motor. From the sump a float-switch-controlled Cameron centrifugal pump, of 314 g.p.m. capacity, driven by a 20-hp. G.E. motor, conveys the water to the 6x20-ft., 4,200-gal. storage tank, 90 ft. above the level of the power house. Make-up water from this tank, because of its hardness, is first treated in a zeolite water softener before it is added to the actual cooling water. A detailed analysis of the raw and treated water is presented in Table II.

Table II—Water Analysis

Raw Water

	Grains per Gallon
Silica	0.699
Oxides of iron and aluminum	0.090
Carbonate of lime	3.809
Sulphate of lime	24.208
Carbonate of magnesia	8.069
Sodium and potassium sulphates	7.759
Sodium and potassium chlorides	28.560
Sodium and potassium nitrates	Trace
Loss	0.390
Total mineral solids	73.584
Organic matter	0.584
Total incrusting solids	36.875
Total non-incrusting solids	37.293
Incrusting solids per 1,000 U. S. gallons, pounds	5.27
Non-incrusting solids per 1,000 U. S. gallons, pounds	5.32

Treated Water

Reaction	Alkaline to M. O.
Observation	Cloudy
Suspended Matter	Trace
Temporary hardness	1.486
Permanent hardness	1.170
Total hardness	2.656
Total alkalinity	13.724
Total acidity	None
Magnesium	trace
Chlorides	16.9863
Sulphates	19.240
Iron	small
pH Value	6
Organic matter	trace
Oil	none

The water contains a little more than $73\frac{1}{2}$ grains of mineral matter and a little more than $\frac{1}{2}$ grain of organic matter per U. S. gallon of 231 cu.in.

The water-softening process consists of washing and regenerating with salt brine. With water of 35 grains' hardness, the softener treats 4,300 gal. of water per regeneration, and requires 96

Table I—Fuel Oil Analysis

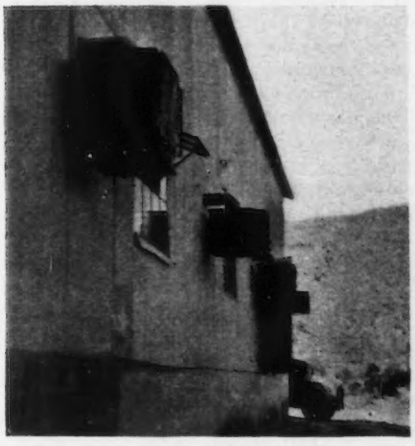
Gravity, degrees Baumé, at 60 deg. F., or 15.6 deg. C.	24
Specific gravity, at 60 deg. F., or 15.6 deg. C.	0.91
Weight per U. S. gallon of 231 cu.in., pounds	7.57
Viscosity, Englers, at 77 deg. F., or 25 deg. C.	0.4
Asphaltum, per cent	25
Calorific value, B.t.u. per pound	19,000
Sulphur content, per cent	1
Flash point, closed cup—Not lower than 150 deg. F., or 65.6 C.	
Water and non-petroleum sediment, per cent	1
Heating value, B.t.u. per gal.	1,406,000
Cost, cents per gal.	4.7

lb. of salt. The capacity of the softener naturally increases proportionally as the hardness of the water decreases. For instance, after a prolonged dry spell the hardness of the raw water drops to about 25 grains, and during this period the softener is capable of treating approximately 7,500 gal. of water per regeneration, with an equal amount of salt; that is, 96 lb.

The normal rate of flow through the softener is about 13 g.p.m. From the water softener the treated water flows by gravity first into a sheet-iron storage sump before it is pumped in a continuous cycle through the engine jackets and cooling tower.

Pumping equipment of the water-cooling system at the Christmas plant consists of three Byron Jackson centrifugal pumps, two of 270 g.p.m., driven by a 10-hp. motor, and one pump of 375 g.p.m. capacity, directly connected to a 15-hp. motor. Valves and bypasses are arranged so that the operator may use one or the other as a spare in case of a pump failure. The temperature of the inflowing water ranges from 68 to 70 deg. F., and that of the outflowing water from 90 to 110 deg. F.

The Braun cooling tower, at an elevation of 35 ft. above the power-house floor, of redwood, measures 35 ft. in height, and has slot bottoms and sides, and it contains ten 12x18-ft. trays and



Filters remove dust from the intake air

a wooden distribution box, equipped with channels and corresponding valves. All hardware is of copper. The cooled water that is collected in the tower pan is returned by gravity to the pump sump.

The General Electric switchboard contains individual operating panels for the mine, mill, filter plant, and the four generators. A primary power line, about 2 miles long and carrying 2,300 volts, connects the power house with the substation, where the current is stepped down to 440 volts. For eight hours during the day period—namely, from 7 a.m. to 3 p.m.—four engines are required to carry the full plant load, and from 3 p.m. to 11 p.m. and 11 p.m. to 7 a.m. three and two engines respectively are in operation.

DAILY POWER REPORT — CHRISTMAS COPPER COMPANY — Date _____, 19__

	Engine No.1				Engine No.2				Engine No.3				Engine No.4			
	Pyro.	Thermo.	Oil Press.	Kw.	Pyro.	Thermo.	Oil Press.	Kw.	Pyro.	Thermo.	Oil Press.	Kw.	Pyro.	Thermo.	Oil Press.	Kw.
Cyl. No. 1																
2																
3																
7 A.M. 4																
5																
6																
Cyl. No. 1																
2																
3																
4																
5																
6																
Cyl. No. 1																
2																
3																
5 A.M. 4																
5																
6																

	7 A.M.	9 A.M.	11 A.M.	1 P.M.	3 P.M.	5 P.M.	7 P.M.	9 P.M.	11 P.M.	1 A.M.	3 A.M.	5 A.M.
P.F.												
Freq.												
A.C. Volts												

	COSTS
Lub. oil (gal.)	
Fuel oil (gal.)	
Wiping rags and waste (lb.)	
Labor (operating)	
Chemicals for water treatment (lb.)	
Supplies	
Maintenance	
Total	

	Engine Down	Time Off	Time On	Reason for Shutdown
Kw.-hr. meter reading				
Kw.-hr. meter reading preceding day				
Kw.-hr. output last 24 hours				
Kw.-hr. output from first of month	No. 1			
Total cost per kw.-hr. to date	No. 2			
Remarks	No. 3			
	No. 4			

Operator No. 1 Shift .....
Operator No. 2 Shift .....
Operator No. 3 Shift .....

Chief Engineer

Diesel power plant report form

Entire absence of guesswork, and the scientific basis on which the plant is operated are additional points worthy of mention. Uneven load distribution between the cylinders, overload, and leaky valves are indicated by a Brown pyrometer installation, provided for each engine.

Thermometers, which are installed on the water discharge pipe of each cylinder head, afford a constant check of water temperatures. In addition, horn signals are given when the water reaches a temperature of 120 deg. F., by a thermostat-operated mechanism, built into the discharge water pipe line of each engine. Lubricating oil shortage is indicated in a similar way, with a relay controlled by the pressure of the oil, and light signals are given in the event of possible failure of the fuel-oil supply pump.

For emergency, a portable pump unit compiling and arranging the data here pipe connections, which can at a minute's notice be attached to the fuel or lubricating oil lines in the event of pump failure, are constantly kept on hand. Safety apparatus mentioned is tested every shift, and a written report relative to its condition is presented daily to the chief engineer. The report sheet shown in an accompanying illustration, with entries made every two hours, facilitates keeping a thorough check on consumption of oils and other material, production, imposed load, and condition of each engine.

Regular maintenance work is carried out periodically. Pistons and cylinder heads are removed every six months and freed of carbon deposits. Exhaust and intake valves are reconditioned and reground every four and six months, respectively. Bearings are inspected every month, but seldom require readjusting. All minor repairs are performed in the repair shed, adjacent to the power house, in which a stock of extra parts, oil, and packing material is also kept. Large engine parts are sent by truck to the company machine shop, where the necessary repairs and readjustments are made.

The operating force consists of the chief engineer, three shift engineers, working eight hours each, and one repair man. Cost data are presented in Table III.

Table III—Operation Costs for Month of November

	Total Cost for Month
Lubricating oil	$377.78
Fuel oil	1,558.99
Wiping rags and waste	26.98
Labor, operating	900.00
Chemicals for water treatment	48.00
Paints, greases, special oils, gasoline	24.40
Total direct operating cost	$2,936.15
Total output	349,600 kw.-hr.
Cost per kilowatt-hour for the month	.008399

Note: No allowance for insurance, interest, depreciation, or taxes has been made in the foregoing costs.

In conclusion, I wish to acknowledge my indebtedness to H. A. Rossell, general manager, for his permission to publish this article, and to C. A. Bilson, chief engineer, for his assistance in compiling and arranging the data here presented.

MANGANESE

in Electrolytic Zinc Practice

[CONCLUSION]

Oliver C. Ralston

Director of Research,
United Verde Copper Company,
Clarkdale, Ariz.

Mr. Caples stated on the stand that the life of anodes at Great Falls was two years, a period almost the same as the life of the lead anodes in the copper sulphate solutions of the adjacent copper refinery. He had never operated with solutions of zinc sulphate free from manganese, and was not qualified to state the comparative behavior of the two solutions. He was therefore able to evade the cross-examining attorney, who tried to make him admit that without manganese the anode scale would peel off too easily. In the interest of the complete truth, it is necessary here to review the recently published work of Hanley, Clayton, and Walsh[1] on alloyed lead anodes. The pure lead anodes used as blanks were operated in zinc sulphate solutions, and also in solutions containing 0.6 gram manganese per liter, at 100 amperes per square foot. The percentages of lead in the cathodes were, respectively 0.190 and 0.064. Cathodes produced from manganese-bearing solutions gave less lead in a considerable series of comparative tests. The inference is that the manganese in the electrolyte has reduced the anode corrosion, or, as the authors put it, "Manganese in the electrolyte lends a degree of passivity to the anode." This conclusion is not justified from the cathode analysis as a basis, because the effect of manganese may have been otherwise. It may have deposited a more adherent scale on the anode and thus prevented small particles of lead peroxide from connecting to the cathodes. It may have coagulated the anode scale into bigger floccules, which settled to the bottom of the cell, and thus failed to reach and contaminate the cathode. At best, both of the lead analyses cited for the cathode zinc are very high. By careful attention to the cells, cathodes may be produced commercially with a lead content of only 0.007 per cent, which is 1/25 and 1/9 of these quoted in the foregoing. Such pure cathodes cannot be made easily with fresh lead anodes, but as soon as the anodes have peroxidized for a few weeks the cathode efficiency increases and the lead content of the cathodes decreases.

Summarizing, no related direct evidence is available of difference in anodic corrosion by solutions of zinc sulphate containing manganese, as compared to zinc sulphate solutions containing no manganese. When the active corroding agents like chlorine are absent from the solutions, the life of the lead is so great that no reliable comparison has been made. No commercial plant has operated on a manganese-free solution and no statement can be made regarding the life of the anodes in such a case. The only approximation is the manganese-free solution of copper refineries, where the life of the anodes is about the same as in zinc electrolysis. Lacking a direct comparison, the manganese anode scale has been described as a spongy and loosely adherent coating, insufficient to prevent attack of the lead. This is borne out by the presence of lead in all manganese anode mud and scale. Corrosion of the lead is not prevented. It may be lessened by the presence of the coating. Even though spongy, the coating, having electrical conductivity, should cause discharge of some oxygen on the surface of the manganese dioxide, and to that extent it should save the lead surface beneath. This, of course, is only my personal opinion, but it seems unreasonable completely to deny any beneficial effort of the manganese scale in decreasing anode corrosion. Whether or no the manganese dioxide actually binds the lead peroxide scale more firmly, as claimed by Harris, is debatable and worthy of investigation. The final conclusion must therefore be that in theory a certain amount of protection of the lead against corrosion seems reasonable, but fair evidence is available to show that in practice the benefit, if any, is rather small.

Another natural conclusion reached qualitatively by A. G. French, when he observed manganese dioxide depositing on his anodes, was that the process offered the opportunity of recovering manganese from the ore. Presumably, the manganese scale should be of high purity and therefore class as "chemical grade" manganese dioxide ore, for which a fair market at 4 to 5c. per pound exists. The recovery and sale of this would be just so much extra profit over that possible by producing electrolytic zinc alone.

This thought causes one to consider the waste of the present electrolytic zinc cell. For every ton of zinc deposited at the cathode 0.247 ton of pure oxygen is liberated at the anode, escaping from the cell at atmospheric pressure, and possibly worth $10 per ton if collected at that pressure. If the anode reaction could be completely utilized, the yield of manganese dioxide would be 1.34 tons per ton of zinc deposited. If this product were marketable as high-grade or "chemical" ore, its value would be as great as that of the zinc produced. Mr. French may therefore be excused for finding the field enticing. He merely jumped at the conclusion that the product was salable. Unfortunately, neither he nor his associates were able to establish the purity nor the marketability of his manganese dioxide. Let us now consider what the witnesses knew on the subject.

S. O. Cowper-Coles testified that he had examined his anode mud in 1895-99 and found it to be a mixed lead-manganese dioxide. Victor Engelhardt regarded the presence of manganese as more favorable than harmful. His firm, Siemens & Halske, had taken out German Patent No. 213,004, April 12, 1908, which describes removal of manganese dioxide mud from the cells, to be returned to the leaching system, where it was used for oxidizing iron, arsenic, and antimony, so that they could be precipitated by hydrolysis. This use was not contemplated by French in his patent and could not be patented by him. It is the one use to which anode mud has been put by nearly all electrolytic zinc plants in the world, and it has been free for their use in most countries where it was not patented by Siemens & Halske. The manganese dioxide must be valuable for some other purposes before French could have an opportunity to claim it.

W. E. Harris testified that it was a valuable byproduct. Challenged during cross-examination, he admitted that the manganese dioxide produced during the three years' operation of the Llansamlet plant had accumulated on a dump. He came back with the claim that it should be of value to the lead smelter for its lead content, and also that the manganese would be of value as a flux.

E. P. Mathewson stated that while he had been metallurgist, superintendent, and manager of various smelters, he had purchased and smelted thousands of tons of manganese-bearing ore and flux for lead blast furnaces. The value of a manganese ore as flux would be about 6c. per unit of 20 lb. of manganese in the ore. According to Mathewson's estimate, mud containing 50 per cent manganese would be worth $3 per ton, in addition to the credit for the lead.

[1]Hanley, H. R.; Clayton, C. Y.; and Walsh, D. F.: "Investigation of Anodes for Production of Electrolytic Zinc." A.I.M.E. Technical Publication No. 321, March, 1930.

The value of the lead he calculated as sufficient to make the total value of the mud 2c. per pound. This would mean about 580 lb. lead per ton of mud, or 29 per cent Pb—a rather high figure. Anode muds of this high lead content are made, but the common lead analysis is from 6 to 10 per cent. This reduces the gross value to about 0.5c. per pound. If anode mud had been worth 2c. per pound it would long ago have paid its way to the lead smelters and been treated. Actually, it has accumulated on dumps at most plants.

Thomas French stated, in testimony, that he had worked in his father's experimental plants and had dealt with the manganese mud. He, as Englehardt, had learned that the oxidized forms of manganese produced in the cells were of value in the leaching step for oxidizing iron. This knowledge he had taken with him to the experimental plant at Trail. He also claimed that the presence of manganese in the solution during purification with zinc or zinc dust was of advantage, but he did not explain the reason for this assumption. He had made a few experiments with the manganese-dioxide precipitate for the production of dry cells of small size, such as are used in the radio and flashlight industries, uses little known in his father's time. Good dry cells could be made with this mud, and therefore it was a product of value.

On this point it might be well to point out that all of the existing electrolytic zinc plants have sought to market their anode mud to battery manufacturers and to paint manufacturers, but without success. The inevitable lead content decreases the "shelf life" of a dry cell, making it deteriorate too rapidly while in stock. I have tried to produce manganese mud of low lead content by using solutions of high manganese content. Solutions containing as much as 50 grams manganese per liter give a mud containing from 1 to 4 per cent lead, presumably corroded from the pure lead anodes. U. C. Tainton has of late experimented with commercial production of manganese dioxide, likewise using strong solutions, and has stated in a private communication that he also is unable to get the lead content sufficiently low. His anodes (see U. S. Patent 1,759,493 of May 20, 1930) consist of lead alloyed with silver and arsenic, to decrease the corrosion and lower the anode voltage. Lead passing into the anode mud from these anodes probably carries down silver. In his patent he specifies that the manganese scale from his alloy anodes is a more finely divided powder containing less lead, so that it is more suitable for dry cells, varnish making, ink manufacture, and other industrial uses. He also points out that the sulphuric acid liberated by decomposition of the manganous sulphate, added to the acid generated from the zinc sulphate, increases the total acid content, permitting more rapid and efficient leaching. Manganous sulphate may be added to the cells and converted into sulphuric acid and manganese dioxide, a more valuable product. Tainton has sold a few small lots of anode mud, but has not disclosed to whom. Apparently, in his hands the problem is nearing solution, and some interesting information should ultimately be gained.

Hey stated on the stand that at Risdon over 1,000 tons of anode mud has accumulated, the manganese being derived from the Broken Hill concentrate treated. Considerable sales effort has been expended to dispose of this product, but with no success. The lead content has repelled the dry-cell manufacturer, and objections have also been made to the calcium sulphate and the zinc content. Calcium sulphate, found in nearly all anode mud, is also present in Tainton's mud. The zinc comes partly from "trees" and irregular growths on the cathodes, that drop to the bottom of the cell with the mud. Some of the zinc redissolves in the acid, but all does not. In spite of the best washing and cleaning, the material at Risdon will contain 3 to 4 per cent zinc.

If it were practically possible to lift the anodes and remove the scale more frequently, certain advantages would be obtained. The rough scale curls up and projects toward the cathodes, creating zones of higher current density, where more zinc is deposited, resulting in "trees" pointing toward the manganese scale. This scale is knocked off by the cell inspectors, especially when they have to lift and straighten a warped anode. At Risdon the anodes are cleaned once every three months, by draining the cells, removing the anode mud, and going over all the anodes to remove the adhering scale with wooden chisel-shaped tools. At Great Falls the original practice (according to R. B. Caples) was to clean anodes every few weeks, but this cleaning always resulted in several days of poor ampere efficiency and rough cathodes, probably on account of the bare lead surfaces exposed, which must again be peroxidized. For this reason the Great Falls practice at the time of the trial was to clean every four to six months. Anaconda has never been able to market its anode scale, on account of the lead content. Blaylock made the same statement in regard to the Trail plant. At Trail, an average of 800 to 1,000 lb. of manganese dioxide scale is returned to the leaching plant every day for oxidation of iron, until only 0.02 gram iron per liter remains in the solution. A total amount of 1.5 tons of anode scale is produced, but most of this is stockpiled. Marketing, repeatedly attempted, has failed to date. Paint makers have considered using it, but have never taken more after testing samples.

Forgetting for the moment, then, the suit over Mr. French's patent, and looking at the value of the anode scale *per se*, we see that it now has an established value as an oxidizing agent in the leaching step of the process. Although an electrolytic zinc plant could be run without the use of manganese dioxide for oxidation of ferrous iron, arsenious oxide, and antimonous oxide, it could not be operated so conveniently. Manganese dioxide is the cheapest material of high oxidizing potential available. With good roasting, very little ferrous iron is present in the calcine and the solution may contain enough of the higher-valency products of manganese, as permanganate, to give sufficient oxidation. Zinc plants sometimes operate for months at a time without addition of manganese. However, at times the addition of some manganese dioxide ore or anode mud is almost a life-saver.

Presence of manganous sulphate in the solution is also of value at other points in the cycle. Mr. Hey said that when using permanganate to purify solutions, black cobalt oxide is difficult to throw down if the solution contains no manganous sulphate to be oxidized to manganese dioxide. He did not explain whether he regarded the manganous ion as a good carrier of oxygen to the cobalt, or whether he wished to form an excess of manganese dioxide precipitate to entangle or adsorb the cobalt oxide, so that it might be filtered out cleanly. C. A. Hansen (private communication) has data to show that the cobalt oxide is adsorbed on the precipitate of hydrated manganese dioxide. He is able to remove the cobalt with a reducing solution like ferrous sulphate, without affecting the manganese dioxide greatly. Purification of zinc solutions is closely connected with adsorption phenomena, and many instances may be cited where a large excess of one impurity must be removed in order to carry down small traces of another compound.

Other interesting information about the recovery of manganese has been obtained at Risdon. Above 15 grams manganese per liter is undesirable in the presence of glue. A special process for its removal is therefore used whenever the content exceeds that figure. The solution, purified from cobalt by the arsenic-zinc-dust method, is fed into cells with 180 grams sulphuric acid and 120 grams zinc per liter, fresh solution being added continuously to keep the acid down to this point. Fresh lead anodes are used in order to get better manganese-dioxide precipitation. Manganese in the solution is stripped to 2.5 grams per liter and zinc to 20 grams per liter, though at a sacrifice in cathodic current efficiency.

I have made tests with this process with a solution containing 17.6 grams

manganese per liter, and collected the following data in a 24-hour test with two batches of solution. In one batch, bright lead anodes were used; in the other, lead anodes coated with manganese dioxide scale resulting from several days' use in solutions of high manganese content. The loosely adhering scale had been scraped from this second cathode. Some of the data collected are given in the following table:

Anode	Solution, Start			Solution, Finish			Ampere Hours	Current Cathode Per Cent	Efficiency Anode Per Cent
	Mn Gm/l	Zn Gm/l	H_2SO_4 Gm/l	Mn Gm/l	Zn Gm/l	H_2SO_4 Gm/l			
Bright	17.6	78.0	147.3	3.9	40.0	206.1	221.2	50.1	26.6
Coated	17.6	78.0	147.3	4.1	26.8	220.0	221.2	71.4	25.7

Apparently the cathode coated with manganese dioxide gave better cathodic current efficiency, although deposition of zinc in such strong acid is difficult. Both sets of anodes were relatively clean and permitted 26 per cent anodic efficiency.

No data have been published on the anode current efficiencies in deposition of manganese dioxide, as a function of solution concentration or any other controllable variable, except the paper by Maier and Van Arsdale (*Trans.* Amer. Electrochem. Soc., Vol. 33, 1918) excluded from consideration at the trial. That paper deals with pure manganous sulphate solutions and not with zinc sulphate solutions containing manganous sulphate, but it is well worth reading by anyone interested in anodic deposition of manganese dioxide. With it as a basis the proper conditions for economic recovery of a suitable grade of manganese dioxide by electrolysis of zinc sulphate solutions can be determined.

A study of the court record on the value of the manganese dioxide deposit reveals that French claimed a process which does not give a valuable deposit, and that most of the anodic manganese dioxide produced in the past fifteen years has gone to waste, with the exception of what has been used by the electrolytic zinc plants themselves. Lead has been the principal objectionable contaminant, with calcium sulphate and zinc as minor contaminants. The lead was known to be present in such a deposit as early as 1895, when Cowper-Coles observed the anode scale. Mr. French therefore made an unwarranted claim.

The foregoing has set forth enough information to allow a positive statement in regard to the benefits actually realized from the use of manganese at any point in the cycle.

The great benefit of manganese is the use of the dioxide, either in natural ores or artificially precipitated, as an oxidant of ferrous iron, arsenious oxide, antimonious oxide, and other easily oxidizable products that can be removed from solution by hydrolysis as soon as the acid is neutralized by zinc oxide in the calcine or by other bases. In the leaching operation these elements remain in solution at the point of neutrality if in the lower stage of oxidation. Neutralization of the cell acid under intensely oxidizing conditions is the secret of success in precipitating iron, arsenic, antimony, germanium, and a few other minor elements. Usually an excess of soluble iron is present to aid in carrying down the other elements. If not, a greater excess of zinc oxide is necessary to perform the same function.

Many other strong oxidizers are available that may be used instead of manganese dioxide for this purpose. Lead peroxide, hydrogen peroxide, sodium peroxide, zinc peroxide, potassium permanganate, ozone, and many others function well, but cost many times as much as manganese dioxide. Some of these are stronger oxidizers than manganese dioxide and produce such remarkable results that they are being considered seriously for the final purification of the solution, in spite of higher cost. The best cathodes produced are from zinc sulphate solutions that have been purified by use of permanganate added to a solution heated to near the boiling temperature and in which is suspended an excess of zinc oxide. This removes the manganous ion, as well as many of the more toxic impurities like cobalt.

Other less important benefits from manganese are known. Field and Harris, when purifying solution with ozone, found the presence of manganous ion was of advantage, possibly by acting as an acceptor of ozone, thereby serving as a carrier of active oxygen to the minute quantities of toxic impurities. I have found that if manganese is present in the feed to the electrolytic cell, the antimony in the solution is largely deposited in the anode scale and mud, so that a solution with too high antimony content at the start of the electrolysis is gradually purified in this manner. The only manipulation required to take advantage of this fact is to lift the zinc cathodes from the cells a few hours after they are put in and before the zinc contaminated with antimony starts to re-dissolve, and placing new cathodes in the partly purified solution. At best this is a compromise. It works best in batch electrolysis, but it will permit operation under otherwise impossible conditions. This is one of the few direct benefits of manganese on zinc deposition.

Finally, I do not deny to Mr. French the possible benefit at the anodes of a coating of manganese dioxide, which may at least partly protect them from corrosion, in spite of the fact that the benefit actually realized has apparently been small. If manganese-dioxide scale actually protected the anodes, all other prior experimenters would have received the benefit, whether they knew it or not. French, by discovering the benefit, would have to restrict himself to describing conditions under which the benefit could be controlled and enhanced —which he did not do, or at least did only imperfectly.

Summary

The litigation over the Canadian patent of A. G. French dealing with electrolytic recovery of zinc and manganese from ores containing both of them has been reviewed critically. Other available information has also been included.

French's patent specification described leaching and electrolytic conditions adapted to treatment of very impure solutions, as had been used by earlier inventors, because of their inability to reach the purification necessary in modern practice of electrolytic zinc deposition.

A claim that the presence of manganese in the solution benefits the cathode deposit by making it more reguline was not substantiated. However, evidence is now available showing that, in the presence of manganese, less lead is to be found in the cathodes, although the evidence needs confirmation.

The idea that manganese precipitating at the anode will depolarize it has been found to be groundless.

A coating of manganese dioxide over a lead anode as a protection from corrosion was shown to be of little benefit in verified practice. Active corrodants must be removed from the solution. A coating of manganese-dioxide scale seems to cause less lead to reach the cathode, as has been mentioned in the foregoing.

The manganese-dioxide scale formed on the anode was not shown to be a valuable commercial form of manganese. Most of the scale formed in fifteen years' practice in the major plants of the world has not been marketed. French also failed to give directions for efficient recovery of the manganese from the solutions. The usual current efficiency in manganese-dioxide deposition under normal zinc plant operating conditions is not much over 1 per cent. This inescapable and incidental recovery of manganese dioxide in the zinc cell was therefore adjudged to be public property.

The true benefit derived from the proper use of manganese is not in the electrolytic part of the cycle but in leaching and purification prior to electrolysis.

A marked benefit of this litigation inheres in the fact that the testimony of a large number of competent and widely experienced zinc metallurgists has indicated what portions of modern electrolytic zinc practice are old and open to public use, and what may be novel.

Trend of Ore Hunting in the United States

[PART TWO]

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TO COME, now, to the specific applications of the new art of ore hunting: What are the indicators or ore-related structures that may be sought where valuable outcrops do not occur? These indicators are discussed under the following headings: (1) Leached outcrop; (2) oxidation slump; (3) mineralization slump; (4) igneous slump; (5) the igneous mineralizer; (6) the ore pipe in bodies of disseminated sulphide; (7) mineral zoning; (8) impervious roof; (9) strong-rock or weak-rock boundary; (10) post-ore cover; (11) the district backbone.

Leached Outcrop — Although rusty blots have generally invited drill holes, tunnels or shafts, later mapping shows that blots have been falsely condemned; for, in the absence of metal value, the old art, favoring the strongest iron stain, tended to avoid the best outcrop. The recent technique, where the original pyrite content was under 15 per cent, reduces the guesswork by classifying the surface into definite grades of promise. Work below, therefore, is raised in efficiency and lowered in cost by systematic exposure and sampling of the leached outcrop in trenches, pits, and short drill holes. Renewed exploration is, for this reason, in progress or in prospect.

As the pyrite content of the ore increases beyond 15 per cent, the outcrop becomes obscure and its exploration risky. In "gossan"—that is to say, the oxidized equivalent of material exceeding 30 per cent in pyrite—only minor spots within the sample are readable and the rest is run together by the liberated iron and acid. But the obstacles are gradually giving way and gossan is becoming less obscure. Residuals of lead, gold, and silver occur; and even those of the more soluble copper, zinc, arsenic, or antimony compounds will be found if they are sought. The outcrop in ground suspected of enargite, for example, is sampled for traces of arsenic. Moreover, protected remnants of the sulphides themselves are found by careful search.

The reading of the leached outcrop illustrates the trend toward studies of the surface as contrasted with studies below ground. Indeed, mining shows that the underground exposure of the geology, until it is fitted into the district framework, tends to mislead rather than to guide.

If the leached outcrop lies on a pitching structure carrying the ore, not directly downward but diagonally to one side, the skill required is of a higher order. Nothing is more natural than to prospect vertically under a surface showing, and no error more common than going under in the wrong place; for only a tight structural control will point an accurate diagonal from the surface downward. Such control has seldom been available in advance of prospecting. The present trend is toward the development of such control, even at the expense of surface excavation. However brilliant the engineer may be, he can no longer be given the privilege, after reading the ground at a glance, of plunging into deep underground operations.

Oxidation Slump—Oxidation shrinkage of heavy sulphide causes cracking and slumping of the rock roof. The most striking effects are created in limestone, where, as at Bisbee, the effect resembles that caused by the mining of a stope of equal size. Indeed, had this effect been recognized early in the Bisbee history, and had the surface cracks and small surface subsidences been carefully mapped, an area which later yielded three thousand million pounds of copper could have been marked out, even to include ore 1,000 ft. below the surface. Oxidation slumps are now being used in Bisbee for the discovery of extensions. Such slumps, it should be noted, are not confined to limestone, for they have been used by Stickney and Kingsbury for discoveries of Ural pyrite-chalcopyrite-gold-silver lenses within schist walls. Little has been done in the United States, outside of Bisbee, on this subject; the separation of the oxidation movements from others of post-ore origin has not become customary. The subject is so simple, however, that nothing can prevent its development from the beginnings already made. It has been neglected merely because it has not been thought of.

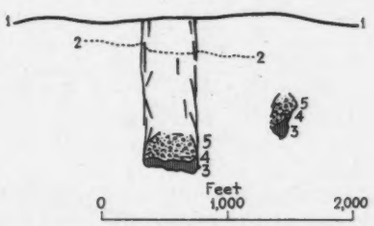

Fig. 3—Sketch illustrating oxidation slump
1, Surface. 2, Marker bed. 3, Oxidized orebody. 4, Preoxidation top of ore. 5, Collapse rubble.

Mineralization Slump—This follows shrinkage during mineralization. For example, strong quartz veins of dip less than 45 deg. show up-springing, quartz-bearing branches separating hanging-wall blocks which have settled unevenly during the footwall mineralization. These branches are structurally late; they take only the later part of the mineral-bearing fluids, and they are richer than is the footwall vein itself. The Comstock, El Oro, Guanajuato, and Goldfield bonanzas are of this hanging-wall variety.

No less marked is the mineralization slump in the disseminated copper orebody. Here we have the summation of the small subsidence movements around the millions of angular rock blocks of which such an orebody, measuring, for example, 1,000 ft. cube, is composed. Such a slump has never been well studied, because no immediate reason for a study has existed. But study is now being regarded as pertinent, and is

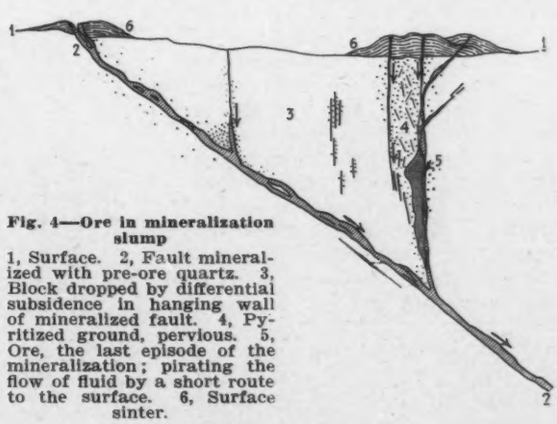

Fig. 4—Ore in mineralization slump
1, Surface. 2, Fault mineralized with pre-ore quartz. 3, Block dropped by differential subsidence in hanging wall of mineralized fault. 4, Pyritized ground, pervious. 5, Ore, the last episode of the mineralization; pirating the flow of fluid by a short route to the surface. 6, Surface sinter.

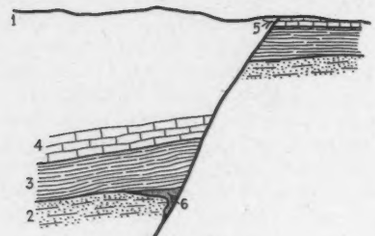

Fig. 5—Ore under impervious shale roof

1, Surface at time of mineralization. 2, Quartzite. 3, Shale. 4, Limestone. 5, Mineralizing crack. 6, Pyritized vuggy quartzite with ore.

already under way in one of the disseminated copper districts. Evidently, mineralization slump is one of the features which might still be visible had the surface remained 1,000 ft. higher, and it therefore supplies a new means of discovering disseminated ore at present hidden under a 1,000-ft. cover.

Mineralization slumping is most marked in certain limestone districts, notably Tintic, in Utah. The great conduit breccia pipes in East Tintic, which are largely unoxidized, show a slumping in the overlying rock which amounts to hundreds of feet and causes striking topographic abnormalities.

The subject here under consideration is capable of some controversy at this stage. We are merely using our own experience, which is as follows: We have never seen an orebody with pressure effects around its edges indicating increase of volume during mineralization; we have seen many orebodies without direct evidence either for or against change of volume; and in every case yielding direct evidence, such as a marker coming in from the walls and traversing the ore, the ore is seen to have shrunk and the roof to have declined.

Igneous Slump—This slump is less known and its connection with ore is vague. But this much is established: Structural work in various districts indicates a sequence—first, silling, arching and doming; second, stock-intrusion breaking across the beds, moving toward or to the surface and accompanied by slumps around the stock boundaries or around certain parts of them; and, third, ore associated with the slump-nodes. Little has been done toward using this subject in finding ore, but it certainly tends to become more obvious in proportion as the structural models are carried to stages of definiteness and refinement. It requires at the outset distinctions between slumps of igneous, of mineralization, and of oxidation origins.

The Igneous Mineralizer—The igneous contact bordered by ore, or the igneous plug surrounded by ore, is the ideal pattern to which all ore-hunters have aspired. Facts have therefore been compiled to support it; contrary facts have been left in obscurity. And, as would be expected, developments do not confirm it as a practical guide to ore. The energetic exploration of contacts has been made with little distinction between good and bad; for the word "igneous" has been accepted as a charm. No other generalization in ore hunting has had implications so vague and confusing.

The present trend is directly opposite. An igneous rock is no better than any other. Like quartzite, it may make cracked and leaky walls; like shale, becoming soft, it may dam the flow; like limestone, dissolving, it may yield collapsing caverns; like greenstone, standing rigid and firm, it may maintain continuous openings, without collapse, tightly walled, containing thin, extensive oreshoots.

Though much nearer the literal fact, this present trend ignores a kernel of genetic truth. There are, indeed, igneous mineralizers bordered by ore in the dreamer's most approved fashion, and there are others more numerous with which ore is less simply but no less surely connected. We have only to get the difference between the mountain of barren granite and the tiny scattered ore intervals along the contacts. Butler, Emmons, Knopf, Schmitt, and Zies are now developing the essence of this difference in the field, with discrimination and restraint.

Actual experience already clearly indicates that it is the conduit which is vital, not the contact. If a conduit has been established from the depths of an igneous mass to and across its edge, such a conduit will contain its best ore where it first encounters the changed conditions of the outer rocks.

Long, even contacts fail ordinarily to develop conduits. On the other hand, conduits are found in tongues of the intrusive rock, advanced either above or alongside of the main mass. The "contact mineral" zones have proved to be in fact alteration halos surrounding such conduits. They are controlled by formation and structure patterns rather than by the contact itself, and have the ordinary value of altered zones in pointing to ore.

Evidently, we are approaching the time when, by a variety of such distinctions, we shall be able to avoid the barren igneous contact and concentrate with assurance on the igneous center and, better still, on those portions of the region around the center which are a good risk for ore.

The Ore Pipe in Bodies of Disseminated Sulphide—Discovery of La Colorada, in Cananea, which, in a single pipe, carries more copper than the district has produced in 30 years, has turned the ore hunter toward the deep development of disseminated sulphide bodies. These bodies were formerly regarded as structureless. Now, the iron-stained outcrop and the sulphide itself become attractive fields in which to seek for nodes of fracturing, subsidence, and primary metal content, indicating pipes. Such features, effaced or ignored in the secondary ores, are traced in the deeper ores unaffected by weathering enrichment. An increased proportion of bornite, molybdenite, or fluorite with a characteristic alteration halo of pink orthoclase, seems to point toward the focal sources. In the explored disseminated mines, the main hope for such pipes is below present mining. Evidently, they are most likely to occur on the major localizing break, if that can be identified. Several may occur strung along that break. Any large pyritized body, carrying even as little as one-quarter of 1 per cent in primary copper, must be considered

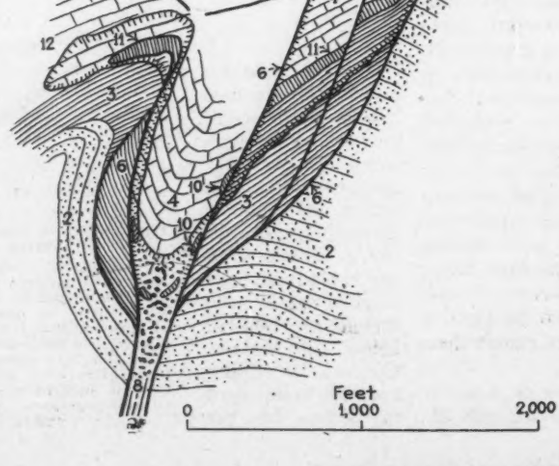

Fig. 6—Ore in mineralization slump. The impervious shale roof of Fig. 5 has collapsed and permitted the ore fluids to move upward to the surface

1. Surface. 2, Quartzite. 3, Shale. 4, Limestone. 5, Rhyolite. 6, Mineralizing cracks. 7, Root conduit filled with breccia of quartzite, shale and limestone, cemented by quartz, barite, galena, sphalerite and pyrite. 8, Fracture zone carrying barite, galena, sphalerite, pyrite, tetrahedrite, gold and silver. 9, Silicified breccia of quartzite fragments in sandy matrix; continuous with tributary "sand-dikes" of similar composition. 10, Lead-zinc-pyrite ore. 11, Lead-silver ore. 12, Upper and outer limit of intense alteration.

interesting from the pipe standpoint. Many explorations of such pyrite are certain to be made; the knowledge of occurrence, now sketchy, is being built up so as to provide a more efficient guidance.

Mineral Zoning—Progressive changes along the conduit in the ratios between various elements have been measured in a few places, as by Broderick in the Calumet district. Such ratios point the direction along the conduit in which exploration should be pushed, whether backward toward the source or forward toward the orifice.

We have instances, as in Tintic, where high-grade lead-silver ores, in the higher portions of a conduit system, change to complex galena-sphalerite-pyrite, low in silver, a few hundred feet deeper. Again, where a conduit passes up from a steep pipe to a flattish manto phase, its mineral contents show abrupt changes; as from pyrite-chalcopyrite-sphalerite to sphalerite-galena (Red Cliff), or from galena-sphalerite to galena-silver (Park City). But the whole subject of mineral zoning is little more than opened up; in no place, for example, has an alteration blot, composed of a network of conduits, been sampled in trenches, for such critical elements as fluorine, arsenic, and molybdenum, in the search for centers of mineralization, expectably coincident with centers of subsidence; in no place have alteration minerals been fairly sampled and measured.[2]

A more fundamental zoning, even less known, consists in differences in the amounts of original copper, lead, and zinc in the fresh (unmineralized) rocks: the opinion begins to grow that rich "magmas" or "magma spots" are essential to ore. The original metals, existing as only a few hundredths of 1 per cent, are determinable only with modern defences against contamination from the fluxes.[3]

But as the obvious areas of metal-rich magmas become exhausted, these determinations must become a part of the ore-hunting technique.

To summarize: Except in commercial amounts of the valuable metals and in a few other cases, the zoning is known through impressions only and constitutes knowledge of the reconnoissance order. When it breaks through into quantitative measurement, it proves useful in ore hunting.

Impervious Roof—In several districts, as in Park City, Utah, a shale or porphyry roof overlying a brittle quartzite or limestone is a dominant fact of the localizing structures; for steep cracks carry and concentrate ore directly under it.

Careful modeling of this kind of structure has proved one of the good guides to ore. The surface rocks, marooned above the impervious layer, yield feeble showings of ore; or if they carry an outcrop of ore, it lies far to one side, where for some reason it has broken through. But if the shale layer is overlain as well as underlain by brittle rock, the crack is almost certain to recur again above, and to bear mineralization that may be mapped. In

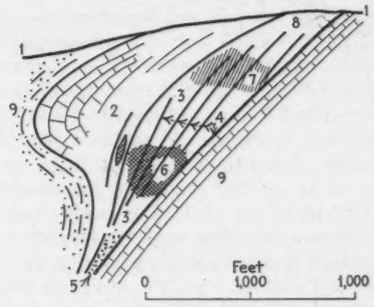

Fig. 7—Primary enrichment in funnel near focal source in disseminated sulphide body

1, Surface. 2, Limestone. 3, Monzonite porphyry, pyritized, carrying 0.3 per cent copper as chalcopyrite. 4, Mineralizing crack. 5, Focal source; a root conduit filled with pyritized, silicified rubble of porphyry and limestone. 6, Primary ore; 1.5 per cent copper as chalcopyrite. 7, Secondary ore; 1.5 per cent copper as chalcocite 8, Capping leached of copper. 9, Barren rocks outside of funnel.

the simpler structure, and if the bottom of the shale is not too deep, prospecting becomes a simple task of finding the best surface spots and sinking on them through the shale.

The structure in most instances, however, has complications. The shale, if as much as 100 ft. thick, is likely to show thickenings, thinnings, thrusts, and Z-folds. Evidently, in proportion to the severity of these complications, the structure requires increasingly careful study for guidance in ore hunting.

Strong Rock or Weak Rock Boundary—This subject concerns a variety of rock pairs, notably: shale-limestone; shale - quartzite; quartzite - limestone; limestone-igneous stock; serpentine-greenstone. Its importance in ore hunting is suggested by the model of Bisbee showing the boundary between the masses of strong rocks and the masses of weak rocks; for the ore lies mainly along that boundary.

Whenever a conduit departs from a stronger into a weaker rock, its capacity to carry ore is in some way affected. Increased plasticity may close the conduit there and change the direction of the flow; or, decreased rigidity may promote opening and enlargement near the boundary. Examples are the gold enrichments in Sierra quartz veins near serpentine masses, and the Kennecott chalcocite masses in limestone or greenstone.

Post-Ore Cover—Simple ore occurrences buried under subsequent cover are found in various Southwest districts where mining terminates at a fault which brings in valley gravel. Less simple occurrences are found at Bisbee and Ajo which have conglomerate, with feeble late mineralization, covering ground into which ore extensions exist. Still less simple occurrences are illustrated by the 10-mile interval between Superior and Miami in which the connecting backbone structure is covered by post-ore volcanics.

Except in following actual ore, the old ore-hunting art, which works in a loose structural framework even in thoroughly opened ground, is helpless with ore under covers. It balks even at a simple fault of 500 ft. displacement; or, accepting the risk candidly, it puts small dependence on structure knowledge, and proceeds to costly operations without the control obtainable in advance.

The new art tends to sharpen that control by all available devices, including geophysical prospecting and drilling. Under the cover itself, in advance of exploration, knowledge is, of course, vague. Yet studies often find thin cover or even windows; they find renewals of old movement along the major fault lines, and renewals of mineralization which make definite marks in the post-ore cover indicating ore below. The tracing of ore under the covers bordering and separating ore districts has become an attractive and legitimate mining activity.

The District Backbone—As was earlier stated, field students find the ore district to lie on a structural break whose movements, beginning even eras before the ore, persist into post-ore times. We may term this break the district backbone.

The district backbone is the chief element in the larger structural frame. It does not carry continuous mineralization, but it is the locus to which the conduits or "centers" are confined and along which they here and there emerge. To it, the orebodies are related as dependent detail, and in accordance with their relation they take various forms and positions. With the relation unrecognized, orebodies seem isolated facts, without laws of occurrence. Once it becomes known, the orebodies become logical, the existence of unexplored ore positions becomes evident, and the directions of the extension of the district are indicated. The backbone is an essential to the understanding of the habits of ore-occurrence.

This all means, to put it broadly, that metal-bearing fluids do not enter the rocks by accident, occupying isolated spots. It implies an attitude of mind in which two orebodies 10 miles apart are presumptively connected with each other. This attitude makes an astonishing difference in the way facts are assembled; it is the most striking single aid to the creation within the given district of a broad scheme of ore hunting.

[2]Harrison Schmitt has made a promising start toward correlating marbleization, measured in trenches, with amounts of sphalerite below.

[3]See Zies's work on "The Valley of Ten Thousand Smokes."

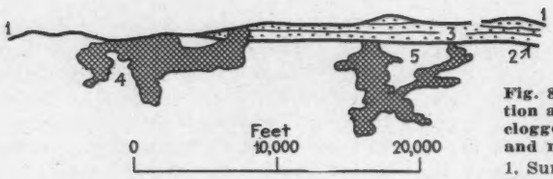

Fig. 8—Ore under lava cover. Section along fracture locus. The lava clogged the orifice of ore district 5 and moved the orifice to district 4. 1, Surface.. 2, Pre-lava surface. 3, Lava, tuff. 4, Known ore district; post-lava. 5, Undiscovered ore district; pre-lava.

In practice, the backbone is not always easy to identify. It may be broken into parts in the rock being mined, and it may attain unity only in rock that is buried. However, in experience, the backbone emerges in proportion to the structural study, and in the few well-studied districts it is well marked.

Geophysical Detection of Detached, Hidden Ore—Recent success in the geophysical discovery of salt domes has released energy for experiments on ore. These have shown that the large distinctive target, not too far away, is easy to hit. The ore principally found has been "massive" sulphide, not over 500 ft. deep.

For more ambitious programs, the inherent complexity of mineral areas has thus far presented impassable barriers. Delicate instruments record the pattern projected on the surface by a maze of features at various depths. This pattern is a resultant derived from unknown primary elements, and in general its interpretation in terms of ore is quite impossible.

The technical difficulties, as would be expected, have concentrated the effective work in the hands of a few professional field-physicists, and the preparation and achievement are high. There is still insufficient correlation between the geophysical record and that obtainable by other means; but it would be astonishing, in view of the paucity of good structural studies, if this defect had been so soon corrected. And there is still a vague understanding among mine operators as to what ought to be expected. But this group of devices is building up as a new department of ore hunting. In another generation it promises to become a routine tool, for use both above ground and underground.

To see this tool in perspective, we must remember that the trouble in interpretation is no less absent in any other department of ore hunting. We get a record by whatever means, and, in any case, we have the problem of interpretation always with us, and in a similar sense.

Expectable Control of Discovery Risk—Discovery of detached, hidden ore at the present time is so hazardous that various American investors are favoring the fresh foreign fields. How far the new art will go in controlling the discovery risk in our own fields, we cannot prophesy. But we can definitely say that the new art is beginning to feel a powerful pressure from the industry itself toward the sharp improvement of the discovery method.

The principal qualification of the technical explorer is his belief that improvement can be made and his equipment to bring, from the world of science and industry, all possible devices which may become available. It is his especial purpose to know everything which might find application. The records of petrography, stratigraphy, structure, and the group of data gathered by geophysical testing are all taken into the account, and the probability of the hidden ore is reckoned. No geologist could claim to see in all respects what the record means in terms of ore. So far as present knowledge goes, various orebodies are pure accidents. But to the geologist is given, irrevocably, the task of sharpening and eliminating the alternatives of possibility, and of building up the art to the point where it will control exploration through improved efficiency alone.

Long experiment only will tell what it will accomplish. Give the new ore-hunting art plenty of ingenious ideas as to where and why ore occurs, and plenty of vigorous experiment in the ground to show which ideas are sound, and it will not be a question whether or not the new art will reduce risks of mining, but, rather, to what difficult tasks of discovery it will ultimately arise.

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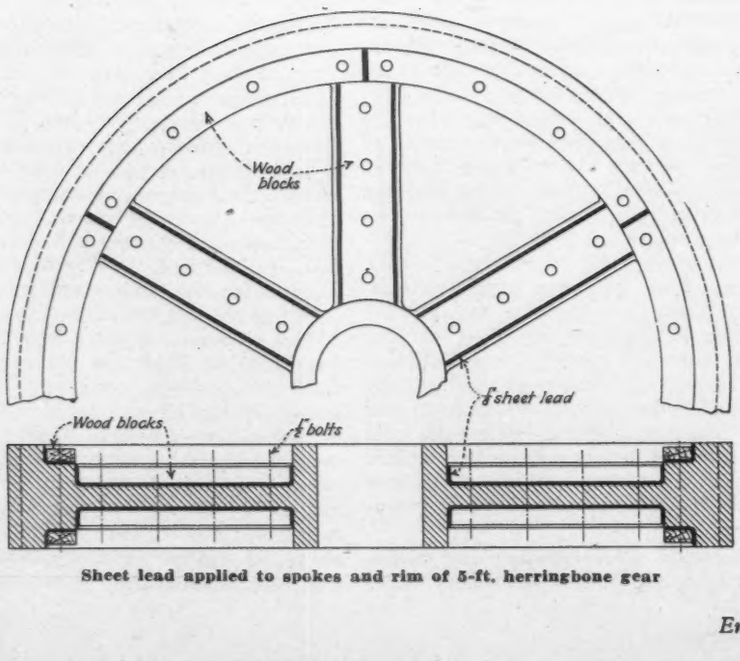
Sheet Lead Silences Noisy Gears



Sheet lead applied to spokes and rim of 5-ft. herringbone gear

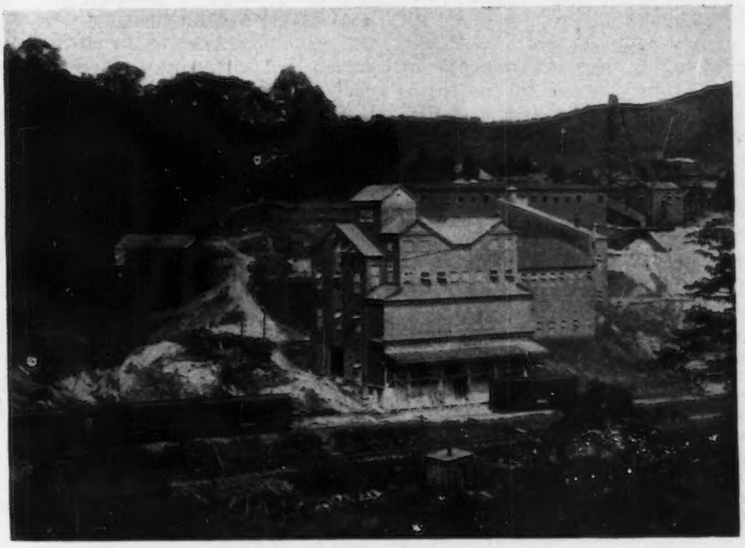
NOISY GEARS on mills, hoists, and other mining machinery are undesirable, particularly because they necessitate constant repairs. Large gears of light construction are most likely to be noisy, excessive vibration resulting in rapid wear of the gear teeth. The noise can be removed either by manufacturing gears of a shock-absorbing material, which is impracticable owing to the excessive costs involved, or by covering with such a material all parts of a gear that are subject to excessive strains.

Recent experiments with a 5-ft.-diameter herringbone gear, driving a large ball mill, gave excellent results when the spokes and rim of the gear were covered with sheet lead. The lead, ⅛-in. thick, was pressed into place and held there with carefully fitted wood blocks and ½-in. bolts, as shown in the accompanying illustration. The cost of remodeling the gear did not exceed $65 for labor and material.

Magnetic Separation Purifies Feldspar

C. H. Peddrick, Jr.,
President, Tennessee Mineral Products Corporation
Vice-President, United Feldspar Corporation

ADAPTATION of a recently developed electro-magnetic induction separator to the processing of ground feldspar has just been made in the plant of the Tennessee Mineral Products Corporation at Spruce Pine, N. C., to obtain a granular product specially suitable for the glass industry. This new process, which has been in operation about three months, produces a crushed feldspar having the same maximum particle size as is standard in the manufacture of glass. Moreover, nearly all of the dust and fine particles are also removed. The result is a free-flowing product which the glassmaker has desired since feldspar was first used in this industry.

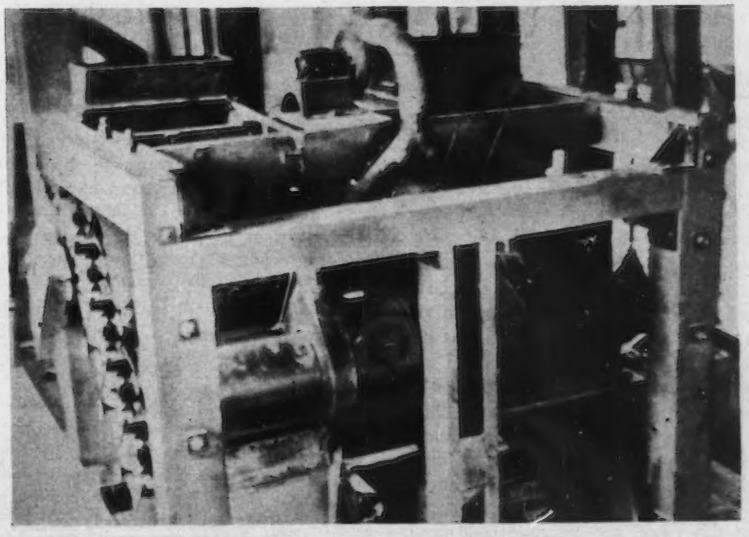


Plant of Tennessee Mineral Products Corporation

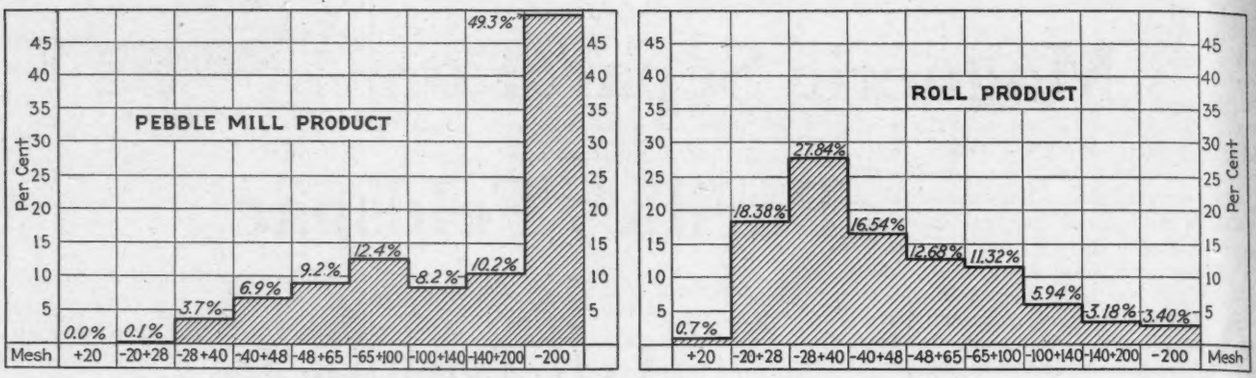
The induction separator almost completely extracts from the raw feldspar all contaminating materials. Metallic iron, garnet, pyrite, tourmaline, hematite, biotite, and even muscovite are removed from grades of material that are equal to the best the glassmaker has received in the past. The net result is an almost chemically pure feldspar in a form best suited for blending with the sand, soda ash, and other raw materials of the glass industry. Accompanying charts of comparative screen tests show clearly the marked difference between the new 20-mesh granular material and ground feldspar produced in the usual manner. Although the new process gives a material that is almost dustless, previous methods of grinding have resulted in about 50 per cent of the product passing a 200-mesh screen.

In the new process, crushing rolls are used instead of the pebble mills that feldspar grinders have employed to the exclusion of all other types of reducing equipment. The feldspar is first broken to about ½ in. maximum size in a jaw crusher before it is fed to the first set of rolls. The roll product is elevated to a double-deck screen, from the lower deck of which is obtained Granular Glasspar —the name given to the new product— of the required maximum size. From the top deck the oversize is returned to the first set of rolls. Crushed material from between the two decks of the screen passes to a second set of rolls. This process is repeated through two more sets of rolls and screens. At the last screen, however, the top deck scalps off mica, and the material from between the two decks is returned to the last set of rolls. All rolls are 12x20-in. Sturtevant, full-balanced type. Double-deck 4x5-ft. Tyler Hum-mer screens are used throughout the screening operations.

As it comes from the final set of rolls, the crushed Glasspar will all pass through the required maximum-size screen. The product contains a minimum percentage of fine particles, since the screens remove the spar from the circuit as soon as it is reduced to 20 mesh. No raw material can be



Induction separator unit. Concentrate chutes are seen at the bottom; feed hoppers and coil-cooling equipment at the top.



Results of comparative screen tests of pebble mill and roll products

granulated, however, without the production of some fine particles. To remove these, the output of the rolls is elevated to a Gayco centrifugal separator. The fines from this separator are delivered to a separate storage bin

The five rotors and polepieces, as well as the rotor-drive mechanism, are seen in this end view of the induction separator

and blended with similar products for other industries that are produced by fine grinding units in the plant. Oversize from the Gayco separator is elevated to Hum-mer screens that classify it into two sizes to facilitate feeding to the induction separators.

Two 50-ton mill storage bins take the surge of crushed Glasspar that prevails between the rolls and the induction separator units. Each of these separator units, as shown in the accompanying illustrations, consists primarily of two large coils. The upper one has three arms or pole pieces and the lower two at each end. A laminated rotor, 30 in. long, revolves under each of these pole pieces, making five rotors on each side, or ten in all. A special feeding device delivers a thin uniform stream of the crushed material over the length of each rotor. As the material passes from one rotor to the next, the magnetized particles are pulled out of the stream by adhering to the rotor and falling into a tailing receptacle. The gradually cleaned Glasspar thus continues on through five successive magnetic separations. At each stage a part of the contaminating materials is removed. The minerals more susceptible to magnetism are taken out at the upper rotors and the feebly magnetic at the lower rotors. Specifically, iron from attrition is removed by the upper or first rotor; garnet, hornblende, and other highly magnetic minerals by the second rotor; biotite by the third; and muscovite by the fourth and fifth rotors.

Belt conveyors and elevators take the output of the magnetic separator units to intermediate storage or mixing bins. Various grades of raw material are handled through each separator unit, stored in the mixing bins, and then, by the corporation's method of chemical control, made to conform to the consumers' specifications. An automatic sampling device between the separators and the mixing bins secures frequent samples. These are used in the aforesaid process of chemical control which the Tennessee Mineral Products Corporation, a subsidiary of the United Feldspar Corporation, has employed for years in making its other products. With this control any specification desired may readily be obtained. After the granular product is finished, it is run over check screens to catch any oversize that might in some way have become mixed with the product prior to shipment. From this check screen the product goes directly to the cars.

The milling department has been in operation since Sept. 15, 1930, and has produced several thousand tons. In its free-flowing, granular nature and uniformly low iron content the commercial product is even an improvement over that obtained in laboratory tests, on which the installation of the first separator unit was based. Rights to the use of the magnetic separator in the feldspar industry are held by the United Feldspar Corporation. The Roessler & Hasslacher Chemical Company, New York City are the corporation's sole sales agents.

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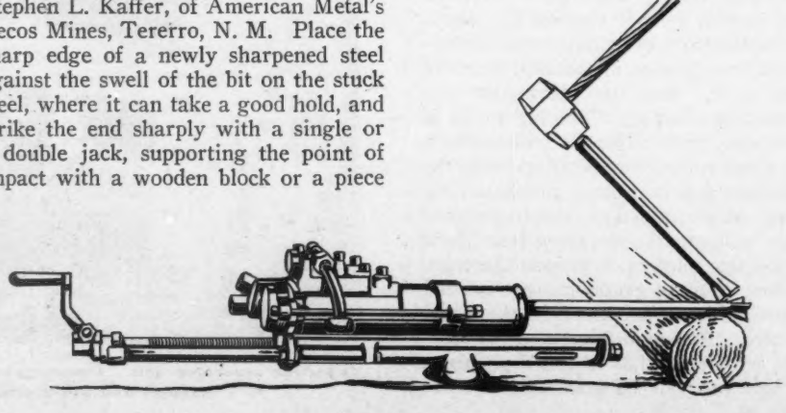
Freeing Stuck Steel

WHEN steel is stuck in rock drills the drills need not necessarily be dismantled or sent to the shop. The stuck steel can be extracted easily in the mine without any special tool, writes Stephen L. Kaffer, of American Metal's Pecos Mines, Tererro, N. M. Place the sharp edge of a newly sharpened steel against the swell of the bit on the stuck steel, where it can take a good hold, and strike the end sharply with a single or a double jack, supporting the point of impact with a wooden block or a piece of rock. Badly stuck steel may thus be easily removed from any type of drill without undue loss of time at the working face.



Digest of Current Technical Literature

Selected from abstracts of articles in the leading technical periodicals, prepared by Engineering Index Service, American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y.

Asbestos Ore Treatment: Rhodesia—"Asbestos Milling in Rhodesia." F. E. Keep. *S. African Min. and Eng. Jl. (Johannesburg),* Vol. 41, Sept. 27, 1930.

MILLING practice at Ethyl mine, Southern Rhodesia; many seams consist of both brittle and non-brittle fiber; special problem eliminating brittle, useless fiber from marketable chrysotile asbestos; cost of producing one ton of fiber from rock containing 1 per cent recoverable asbestos £15 to £18. Abstract of bulletin issued by Rhodesian Geological Survey.—E.I.S. New York.

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Boreholes, Exploratory: Russia—"Exploratory Core Drilling of Inclined Boreholes." I. N. Yephimov. *Gorniy Jl.,* No. 1, Jan., 1930.

GENERAL discussion of subject with special reference to Russian experience in Donetz coal basin; logs of corings. (In Russian.)—E.I.S. New York.

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Zinc-Ore Treatment: Coley Process—"The Coley Process Applied to Zinc Production." *Indus. Chemist,* Vol. 6, No. 68, Sept., 1930.

RESULTS and operating experiences at Dartford works of Zinc Manufacturing Company, using Coley process for reduction of oxides and carbonates to metal.—E.I.S. New York.

•

Mine Hoists: Pneumatic—"New Pneumatic Winches." R. Vogdt. *Fördertechnik und Frachtverkehr,* Vol. 23, No. 21, Oct. 11, 1930.

HOISTING units driven by compressed air; both reciprocating and geared motors are described; illustrations of different German makes.—E.I.S. New York.

•

Non-Ferrous Metal Industry: Germany—"Germany as Metal Consumer and Producer." A. Marcus. *Internationale Bergwirtschaft und Bergtechnik,* Vol. 23, No. 18, Sept. 30, 1930.

IN YEARS 1914-1926, Germany's consumption of non-ferrous metals was considerably less than in previous period; reasons for this are discussed, and development and prospects of mining and metallurgical industry.—E.I.S. New York.

•

Mines and Mining: Cementing—"Underground Cementation as a Means of Dealing with Water Troubles at Geduld Proprietary Mines." E. P. Cowles. *Colliery Guardian,* Vol. 141, No. 3633, Aug. 15, 1930.

CAVITIES in dolomite have acted as reservoirs feeding fissures intersected by underground workings; water handled during sinking of seven shafts varied from 45,000 to 500,000 gal. per 24 hours; sealing of water fissures by Francois cementation process was started in 1917; notes on practice.—E.I.S. New York.

•

Crushers: Electric Drive—"Synchronous Motors on Gyratory Crushers." *Elec. World,* Vol. 96, No. 12, Sept. 20, 1930.

APPLICATION of direct-connected synchronous motors to Kennedy-Van Saun gyratory crushers resulted in unique design of motor; construction of motor is now reversed; stator of motor is on inside and bolted to frame of crusher; rotor is usual pulley wheel of this type of crusher, within which is mounted field poles.—E.I.S. New York.

•

Mines and Mining: Mechanical Loading—"Tests of Mechanical Loading Made at Homécourt in 1928-29." J. Ollivier and S. Bounakoff. *Revue de l'Industrie Minérale,* No. 233, Sept. 1, 1930.

MANY American loaders have been tested recently in Lorraine iron mines; results of tests with Goodman loader at Homécourt over period of eight months.—E.I.S. New York.

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Mine Cars—"Mine Cars." F. Riedig. *Fördertechnik und Frachtwerkehr,* Vol. 23, No. 21, Oct. 11, 1930.

DISADVANTAGE of older types; modern hopper cars, saddle-bottomed cars.—E.I.S. New York.

•

Iron Mines and Mining: Loaders—"Mechanical Loading." Duruy. *Annales des Mines,* Vol. 17, No. 5, May, 1930.

RESULTS of tests in iron mines of eastern France with different types of loaders.—E.I.S. New York.

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Copper Refining: Electrolytic—Dimensioning of Baths in Electrolytic Plants and Its Influence on Initial Costs. F. Vogel. *Metallbörse,* Vol. 20, Nos. 58, 60, and 62, July 19, 26, and Aug. 2, 1930.

DISCUSSION is based on experiences of some copper refineries; in none of examples cited, with exception of old Great Falls plant, is there any indication that, in design of bath, consideration was given to relation of bath size to entire plant; importance, however, of this factor, was demonstrated.—E.I.S., New York.

•

Lead-Zinc Mines and Mining: Siberia—"Mechanical Equipment of Lead and Zinc Ore Territory, Tetiuhe, East Siberia." Woebling. *Metall und Erz,* Vol. 27, No. 19, Oct. 1, 1930.

ELECTRIC and mechanical equipment of mines in Tetiuhe, on the Sea of Japan, including underground mining and haulage equipment, ore-treatment equipment and new power plant, and railroad transporting ore from mine to preparation plant, and concentrates to harbor.—E.I.S. New York.

•

Copper Ore Treatment: Concentration—"Ore Concentration at Lenin and Shaumyan Group of Zangezur Deposits." L. M. Alexeyev and S. N. Zubaryov. *Tzvetniye Metalli,* No. 6, June, 1930.

REPORT on practice developed in quartz-copper and copper-zinc mines near Persian border of Russia; flow sheet and results of experimental runs; methods of differential flotation. Pneumatic and mechanical flotation machines. (In Russian.)—E.I.S. New York.

•

Furnaces, Metallurgical: Magnesite Lining—"Use of Magnesite and Construction of Magnesite Arches in Copper Furnaces of Krassny Viborzhetz." D. D. Voyeykov. *Tzvetniye Metalli,* No. 7, July, 1930.

REPORT from plant recovering brass scrap; maintenance of magnesite linings; corrosion of magnesite masonry; jointing magnesite lining with other refractory materials. (In Russian.)—E.I.S. New York.

•

Rock Drills: Pneumatic—"Need of Careful Heat-Treatment in Making Rock Drill." H. R. Simonds. *Steel,* Vol. 87, No. 11, Sept. 11, 1930.

MANUFACTURING methods and equipment at plant of Ingersoll-Rand, Philipsburg, N. J.; heat-treating department handles about 30 tons of material a day.—E.I.S. New York.

•

Mines and Mining: Equipment, Aluminum—Use of Light Metal in Mines. E. Lohrke. *Metall und Erz,* Vol. 27, No. 20, Oct., 1930.

DIFFICULT working conditions in mining favor use of light metal, such as aluminum, in ventilating equipment, water pumps, lighting equipment, mining tools, stowage, and in hoisting equipment.—E.I.S. New York.

•

Iron-Ore Treatment: Sintering—"Sintering of Fine Ore at Iron Mines of Rouina." Fournier. *Revue de l'Industrie Minérale,* No. 235, Oct. 1, 1930.

PLANT with 220 tons' daily capacity, two furnaces working simultaneously.—E.I.S. New York.

•

Zinc-Ore Treatment—"Rationalization of Zinc-Ore Reduction in Horizontal Muffles." H. Beermann. *Metallbörse,* Vol. 20, No. 86 and 88, Oct. 25 and Nov. 1, 1930.

MECHANISM of zinc-recovery process in horizontal muffles is studied; diagrams of ideal and actual reduction.—E.I.S. New York.

•

Conveyors: Speed Reducers—"Modern Drives Used in Handling Ores and Cement." R. Trautschold. *Matls. Handling and Distribution,* Vol. 5, No. 2, Nov. 1930.

SPEED-REDUCER drives used for conveyors and elevators in ore and cement mills.—E.I.S. New York.

•

Gold Mines and Mining: Placer—"Hydraulic Mining in Colombia." R. S. Botsford. *Min. Mag.,* Vol. 43, No. 3, Sept. 1930.

ACCOUNT of progress and of hydraulic mining activities near Medellin, department of Antioquia, Colombia.—E.I.S. New York.

•

Dredging: China—"The Relation of the Material to Method of Dredging in the Wangpoo River and Yangtze Estuary." H. Chatley. *Far East Rev.,* Vol. 26, No. 8, Aug. 1930.

DISCUSSION of present practice with non-propelling bucket dredges in Chinese waters; theoretical analysis of practice; value of pore coefficient.—E.I.S. New York.

Platinum Ore: Russia—"Some Characteristics of the Primary Platinum Ores of Ural." A. G. Betekhtin. *Gorniy Jl.*, No. 1, Jan. 1930.

CHEMICAL composition of primary platinum; structural peculiarities and chemical composition of platinum-bearing copper ore; properties of iridium species of platinum ore; method of testing samples at concentration plant; factors bearing on mechanical extraction of platinum. (In Russian.)—E.I.S. New York.

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Mines and Mining: Diesel Engines — "Diesel Power in the Canadian Mining Industry." J. Ander. *Can. Min. and Met. Bul.*, No. 222, Oct. 1930.

NOTES on increasing use of Diesel engine in mines of Canada; operating cost, including capital charges, of Diesel-engine plant of 220 b.hp.; cost is $47.12 per b.hp. per year, including interest and depreciation on plant cost of $20,000 over period of fifteen years; Diesel electric plant with three 500-b.hp. engines direct-connected with 400-kva. generators estimated to cost $66.87 per electric hp. per year, depreciation twenty years.—E.I.S. New York.

●

Scrapers: Electric Drive — "Electric Equipment for the Scraper Winch." Just. *Elektrizität im Bergbau*, Vol. 5, No. 7, July 20, 1930.

ELECTRIC driving equipment, control and remote control; performance characteristics; application.—E.I.S. New York.

●

Mines and Mining: Materials Handling —"Mechanical Handling and Mining Operations." F. J. Garland. *Mech. Handling*, Vol. 17, No. 11, Nov. 1930.

FEATURES and methods of mine material handling and transport; primitive method of handling ore in French penal settlement; electric mine hoists; depth indicator. —E.I.S. New York.

●

Mines and Mining: Subsidence — "Protection of Dwellings Against Mine Damage." H. Wolf. *Glückauf*, Vol. 66, No. 36, Sept. 6, 1930.

TWO new methods are described; entire depth of basement walls may be designed as beams of great inertia moments, producing inexpensive means of sustaining greatly increased bending moments caused by mine working.—E.I.S. New York.

●

Tin Dredging—"Dredging for Alluvial Tin." H. W. Sewell. *Elec. Rev.*, Vol. 107, No. 2756, Sept. 19, 1930.

DESCRIPTION of new electrical plant on west coast of Siam; settling tables, electrified steam-dredge; specification of dredging and electric equipment.—E.I.S. New York.

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Compressed Air Lines: South Africa— "Compressed Air System on the Rand." B. Price. *S. African Eng.*, Vol. 41, No. 9, Sept. 1930.

PIPE system of Victoria Falls and Transvaal Power Company supplies compressed air to mines on Central Rand; consumers are fed by short single-branch pipes from network of mains, affording duplicate supply to all branches except those east of Rosherville; anchoring of bends; joints; joint packing; drainage of condensed moisture and collection of grit; internal and external corrosion; value of aluminum paint.—E.I.S. New York.

●

Zinc Mines and Mining: Tasmania — "Tasmanian Zinc Sulphide Ores"—*Chem. Eng. and Min. Rev.*, Vol. 22, No. 263, Aug. 5, 1930.

NOTES on Read-Rosebery mines; Rosebery mine, at town of Rosebery; Hercules mine, at Williamsford; mill designed to treat 3,000 tons of ore per week; during three years 81,000 tons of Rosebery and 32,000 tons of Hercules have been treated at experimental mill at Zeehan, average grade being: zinc, 22.4 per cent; lead, 6.3 per cent; silver, 7.3 oz. per ton, and gold 2.1 dwt. per ton.—E.I.S. New York.

●

Placer Deposits: Prospecting—"Alluvial Prospecting in South America." H. L. Holloway. *Min. Mag.*, Vol. 43, No. 2, Aug. 1930.

DETAILS of shaft and hand drilling methods used in prospecting certain alluvial deposits in Ecuador and Colombia.—E.I.S. New York.

●

Gold Mines and Mining: Ontario— "McIntyre-Porcupine Mines, Ltd." J. A. McRea. *Can. Min. Jl.*, Vol. 51, No. 41, Oct. 10, 1930.

BRIEF analysis of enterprise; in last seven years mine has produced gold at rate of $3,600,000 to $4,500,000 yearly; ore reserves increased from $8,500,000 in 1924 to $22,000,000 at end of 1930; new 2,000-ton mill under construction; old shrinkage-stoping method abandoned and ore is drawn as broken, preventing dilution and raising grade of ore $1 per ton with net increased profit of 50c. per ton.—E.I.S. New York.

●

Mines and Mining: Blasting Effects— "Vibration of Surface Structures Due to Underground Mine Blasting." K. Preclik. *Glückauf*, Vol. 66, No. 29, July 19, 1930.

OSCILLATION from blasting in mines can be easily recorded as sinusoidal curves with aid of vibration meters; abscissa signify time and ordinates deviation of soil from its quiescent state; results of tests.—E.I.S. New York.

●

Air Separators—"Degree of Separation of Air Separators," H. Madel. *Zement*, Vol. 19, No. 41, Oct. 9, 1930.

REFERENCE is made to article by P. Rosin and E. Rammler in Nos. 26 and 32 of 1929 volume of same journal, critically discussing formulas developed by these authors for calculation of air separators; reply of Rosin and Rammler appended.—E.I.S. New York.

●

Mines Hoists: Electric—"Recuperation of Energy of Electric Mine Hoists." L. Lahoussay. *Revue Universelle des Mines*, Vol. 4, No. 8, Oct. 15, 1930.

IMPORTANCE and practical value of recuperation of electrical energy and how it is effected; direct-current and induction motors. —E.I.S. New York.

●

Mine Ventilation: Design—"Effects of Ventilation on Extent of Mineable Area Along Strike and Estimate of Cost of Power Consumed in Ventilation." A. M. Zeitlin. *Gorniy Jl.*, No. 1, Jan. 1930.

THEORETICAL discussion; formulas and charts based on L. D. Shevyakov's formula published in 1928. (In Russian.)—E.I.S. New York.

●

Dredges: Diesel-Electric—"The Diesel-Electric Suction Dredge 'La Sangsue' for the Port of Boulogne sur Mer." H. Fischer. *V. D. I. Zeit.*, Vol. 74, No. 41, Oct. 11, 1930.

DESCRIPTION of hull and equipment. Special reference to 600-kw. Diesel-electric plant used for ship propulsion and for operating pump motors; power plant includes 850-hp. M.A.N. seven-cylinder Diesel engine, 250 r.p.m., coupled directly with d.c. generator of 600 kw. and auxiliary dynamo of 175 kw.—E.I.S. New York.

●

Cement Plants: Grinding Mills — Employs Air Separation to Reduce Power Cost in Finish-Grinding Mill." *Pit and Quarry*, Vol. 21, No. 2, Oct. 22, 1930.

NEW unit at Missouri Portland Cement, two finish-grinding mills are Allis-Chalmers 9½x8x40-ft., four-compartment Compeb mills; each is connected with two Sturtevant 16-ft. air separators; each separator is belt-driven by Westinghouse 40-hp. motor, 175 r.p.m.—E.I.S. New York.

●

Miners' Lamps: Electric—"Development of Electric Mine Lamps." H. Winkelmann. *Bergbau*, Vol. 43, No. 41, Oct. 9, 1930.

DEVELOPMENT of mine lamps is reviewed and several constructions are illustrated; lamps with alkaline batteries are given preference over lamps with lead batteries because they have longer life and are insensitive to self-discharge.—E.I.S. New York.

●

Copper Mines and Mining: Electrification—"Electrification of the Utah Copper Mine." R. Corfield. *Gen. Elec. Rev.*, Vol. 33, No. 11, Nov., 1930.

REASONS why electric shovels and locomotives are used in one of largest mining undertakings in world; comparative shovel costs and characteristics; power input graphs for d.c. and a.c. shovels; electric locomotives; overhead line construction; locomotive data; control room; power transmission; specifications of forms of electric locomotives and shovels.—E.I.S. New York.

●

Phosphate Rock: Grinding—"Dust Control in Phosphate Rock Grinding." W. H. Gabeler. *Indus. and Eng. Chem.*, Vol. 22, No. 10, Oct. 1930.

METHODS used by Davison Chemical Company, Baltimore, Md., to control and recover dust produced when grinding phosphate rock—E.I.S. New York.

●

Dredges: Diesel — "Diesel - Powered Bucket-Chain Dredge." Ebelt and Steffens. *Bautechnik*, Vol. 8, No. 35, Aug. 15, 1930.

DESCRIPTION of German dredge measuring 12x5.5 m. and drawing 0.9 m., capacity 40 cu.m. per hour; power equipment one Deutz compressorless horizontal four-stroke Diesel engine, Model MJH, capacity 25 hp., 400 r.p.m.—E.I.S. New York.

●

Mine Hoists — "Modern Conveying in Steep Blind Pits: Designs of Two-Drum Hoists." Spieker. *Bergbau*, Vol. 43, No. 38, Sept. 18, 1930.

SEVERAL arrangements for hoisting two cars on one rope from joists with two drums; costs of construction and operation are compared for different arrangements.—E.I.S. New York.

●

Copper Industry—"The Rôle of Central Africa in World Copper Production." E. Hentze. *Zeit. für Berg, Hütten und Salinenwesen*, Vol. 78, No. 4, 1930.

BRIEF review of copper resources of world; geology of deposits and description of mines of Katanga and North Rhodesia; coal and power supplies of Central Africa; study of mining and transportation costs of African and American copper; statistical data on American copper companies; world production and consumption of copper.—E.I.S. New York.

PATENTS

Concentrating. No. 1,781,810. Nov. 18, 1930. F. C. Dyer, Toronto, Canada.

Design for a concentrating table.

Prospecting. No. 1,782,445. Nov. 25, 1930. F. Rieber, San Francisco, Calif.

A method for geophysical prospecting.

Screen. No. 1,779,202. Oct. 21, 1930. J. Winston, Chuquicamata, Chile.

Design for a vibrating screen.

Electrolytic Iron. No. 1,782,909. Nov. 25, 1930. R. D. Pike, Piedmont, Calif.

Design for a cell for the production of electrolytic iron.

Screen. No. 1,783,617. Dec. 2, 1930. F. H. Haselow and C. Redig, Milwaukee, Wis.

Design for a vibrating screen.

Filter. No. 1,780,905. Nov. 11, 1930. R. S. Butler, assignor to Southwestern Engineering, Los Angeles, Calif.

Design for a plate filter.

Car Dumper. No. 1,778,821. Oct. 21, 1930. A. Allen, assignor to Allen & Garcia Company, Chicago, Ill.

Design for a rotary car dumper.

Conveyor. No. 1,779,454. Oct. 28, 1930. J. A. Traylor, asignor to Traylor Vibrator Company, Denver, Colo.

Design for a vibrating conveyor.

Grinding Mill. No. 1,780,915. Nov. 11, 1930. H. Hardinge, assignor to Hardinge Company, York, Pa.

Design for a ball mill.

Crusher. No. 1,781,892. Nov. 18, 1930. G. W. Borton, assignor to Pennsylvania Crusher Company, New York, N. Y.

Design for a hammer crusher.

Mill. No. 1,781,904. Nov. 18, 1930. C. A. Jamison, assignor to Pennsylvania Crusher Company, New York, N. Y.

Design for a hammer mill.

Concentrating. No. 1,781,971. Nov. 18, 1930. C. N. Bielenberg, Deer Lodge, Mont.

Design for a concentrating table.

Magnetic Separator. No. 1,781,998. Nov. 18, 1930. J. Bing, assignor to Magnet-Werke G.m.b.H., Eisenach, Germany.

Design for a magnetic separator.

Zinc Oxide. No. 1,781,702. Nov. 18, 1930. F. E. Pierce, New York, N. Y.

Zinc oxide is produced by reducing zinc ores in a reverberatory furnace, volatilizing the metallic zinc, and oxidizing the vapor in a separate combustion chamber.

Electric Furnace. No. 1,782,359. Nov. 18, 1930. F. Linnhoff, assignor to Ajax Electrothermic Corporation, Ewing Township, N. J.

Design for an electric induction furnace.

Sulphur. No. 1,782,225-26. Nov. 18, 1930. R. F. Bacon, Bronxville, N. Y.

Process for recovering sulphur from pyrites by treatment of the pyrites with steam at 600 to 700 deg. C. in a rotating kiln and treating the mixture of gaseous sulphur and hydrogen sulphide with sulphur dioxide for complete recovery of the sulphur as elemental sulphur.

Volatilization Process. No. 1,782,418. Nov. 25, 1930. U. A. Garred, assignor to Anaconda Copper Mining Company, Anaconda, Mont.

Finely divided fuel and air are forced through molten slag, reducing and expelling the volatile metals, which are collected as a fume.

Refining Antimony. No. 1,780,944. Nov. 11, 1930. H. Roscher, assignor to Norddeutsche Affinerie, Hamburg, Germany.

Method for refining antimony by electrolysis of an acid antimony trifluoride solution.

Mine Conveyor. No. 1,781,259. Nov. 11, 1930. A. Welsh and G. Raw, New Washington, England.

Design for a mine conveyor consisting of a train of tubs with sliding bottom plates.

Coal Pulverizing. No. 1,781,572. Nov. 11, 1930. W. J. Drummond, assignor to Ashington Coal Company, Newcastle-upon-Tyne, England.

Design for a mill operating in closed circuit with an air classifier.

Casting Metals. No. 1,782,920. Nov. 25, 1930. D. W. Gray and J. J. Williams, assignors to Hazel-Atlas Glass Company, Wheeling, W. Va.

Design for an apparatus for casting metal slabs, with air-tight molds filled from the furnace by application of vacuum.

Cobalt Metallurgy. No. 1,783,046. Nov. 25, 1930. N. E. Lenander, assignor to Orkla Grube A. B. Lökken, Norway.

Separation of cobalt from iron in a leach solution by oxidizing the iron with an alkali metal chlorate and precipitating the ferric iron thus obtained, leaving the cobalt in solution for special treatment.

Copper Leaching. No. 1,782,841. Nov. 25, 1930. C. E. Carstens, assignor to Anaconda Copper Mining Company, Anaconda, Mont.

In percolation-leaching of crushed copper ore 4 to 5 per cent moisture by weight is added to the ore before it is introduced into the leaching vat.

Platinum Metals. No. 1,779,457. Oct. 28, 1930. H. E. Zshiegner, assignor to Baker & Company, Newark, N. J.

Solution for electrolytic deposition of metals of the platinum group, consisting of an aqueous solution of the chloride of these metals and an excess of sodium nitrite containing ammonia.

Mine-Shaft Construction. No. 1,783,812. Dec. 2, 1930. R. V. Proctor, assignor to Commercial Shearing and Stamping Company, Youngstown, Ohio.

A mine shaft construction consisting of metal liners forming an inner lining of the shaft, an outer lining of concrete, water rings arranged outside the concrete lining, with means for draining the water collected in the rings.

Die Casting. No. 1,779,525. Oct. 28, 1930. E. A. Anderson, assignor to New Jersey Zinc Company, New York, N. Y.

An alloy of zinc of purity 99.99 per cent or more with 2 to 5 per cent aluminum and 0.01 to 0.3 per cent magnesium.

Casting Copper. No. 1,779,534. Oct. 28, 1930. W. F. Eppensteiner and H. M. Green, assignor to American Metal Company, New York, N. Y.

Method for vertical casting of copper cakes.

Zinc Metallurgy. No. 1,779,973. Oct. 28, 1930. F. R. Kemmer, assignor to American Cyanamid Company, New York, N. Y.

Recovery of precious metals from raw zinc by segregation and distillation.

Tin. No. 1,780,106. Oct. 28, 1930. E. A. Ashcroft, Ashburton, England.

Tin-bearing material is mixed with a carrying salt and a collecting metal and heated to cause the tin to alloy with the collecting metal.

Furnace Cooling. No. 1,783,284. Dec. 2, 1930. H. F. Easter, assignor to American Smelting & Refining, New York, N. Y.

Protection of the inside of a metallurgical furnace against scorifying action by a layer of steam.

Flotation of Phosphates. No. 1,780,022. Oct. 28, 1930. J. W. Littleford, assignor to Minerals Separation North American Corporation, New York, N. Y.

Flotation of phosphate-bearing material by agitation of an alkaline pulp with a float-assisting substance.

Tube Mill. No. 1,780,132. Oct. 28, 1930. W. Jaedel, assignor to Maschinenbauanstalt Humbolt, Cologne-Kalk, Germany.

Design for a tube mill with air classifier.

Treatment of Flue Dust. No. 1,780,833. Nov. 4, 1930. W. J. McGurty, assignor to Bartlett Hayward Company, Baltimore, Md.

A process for treatment of flue dust prior to furnacing.

Rock Drills. No. 1,779,107. Oct. 21, 1930. J. E. Renfer, assignor to Cleveland Rock Drill Company, Cleveland, Ohio.

Design for a rock-drill retainer.

Rock Drills. No. 1,779,107. Oct. 21, 1930. J. E. Renfer, assignor to Cleveland Rock Drill Company, Cleveland, Ohio.

Design for a valve-stem lock.

Rock Drills. No. 1,778,939. Oct. 21, 1930. E. G. Gartin, assignor to Sullivan Machinery Company, Chicago, Ill.

Design for a rock drill.

Rock Drills. No. 1,781,021. Nov. 11, 1930. E. B. Lear, assignor to Ingersoll-Rand Company, Jersey City, N. J.

Design for a valve for a rock drill.

Rock Drills. No. 1,781,032. Nov. 11, 1930. S. B. Redfield, assignor to Ingersoll-Rand Company, Jersey City, N. J.

Design for a connection for drill rods.

Rock Drills. No. 1,782,102. Nov. 18, 1930. W. A. Smith, Jr., assignor to Ingersoll-Rand Company, Jersey City, N. J.

Design for a rock-drill valve.

Rock Drills. No. 1,783,290. Dec. 2, 1930. G. W. Hulschizer, assignor to Ingersoll-Rand Company, Jersey City, N. J.

Design for an anchor for rock drills.

Rock Drills. No. 1,783,829. Dec. 2, 1930. J. C. Curtis, assignor to Ingersoll-Rand Company, Jersey City, N. J.

Design for a rock-drill valve.

Personal Notes . . . Comment . . . Criticism

Ralph W. Stone, of the Pennsylvania State Geological Survey, has returned to his headquarters at Harrisburg, after a two months' stay in Colombia.

G. A. Burr is engaged in opening several new gold properties on the Nayo River, two days' journey west of Guadalupe y Calvo, Chihuahua, Mexico.

Heath Steele, vice-president of American Metal, has returned to the New York office of that company from a several months' stay in Northern Rhodesia.

Charles Phipps, formerly an employee of Old Dominion Mining, at Globe, Ariz., is now on the engineering staff of Chile Exploration, at Chuquicamata, Chile.

George H. Harbordt, general manager of the Compañia Minera de Peñoles, is in New York. He expects to return to Mexico after an absence of about two months.

A reader of *Engineering and Mining Journal* wishes to dispose of a small collection of rare but not extremely valuable books on ancient European mining practice. Inquiries sent to this office will be forwarded to him.

R. G. Wayland, assistant general manager of Homestake Mining, Lead, S. D., was recently in San Francisco en route to Bodie, Calif., where his company has an interest, with Treadwell Yukon, in the reopening of old mines.

Dr. W. O. Hotchkiss, president of the Michigan College of Mining and Technology, was in New York City on Dec. 10, where he broadcast from a national network of radio stations, talking on the subject, "Our Gifts from the Great Ice Age."

G. H. Rupp, general superintendent of the iron mines and quarries of the Colorado Fuel & Iron Company, Pueblo, Colo., has been named manager of a newly created mining department of that company, which will direct all mining and quarrying operations. Mr. Rupp has been with the company since early in 1929, at which time he came from Calumet & Hecla Consolidated.

John D. Ryan, chairman of Anaconda Copper, is one of six distinguished industrial leaders after whom have been named six study halls in the new College of Foreign and Domestic Commerce at Notre Dame University, the gift of **E. N. Hurley,** wartime chairman of the United States Shipping Board. An oil painting of Mr. Ryan is to be hung in the Ryan hall, to remind students of "his boyhood struggles, phenomenal success, and subsequent leadership."

Duncan MacVichie, who is vice-president and general manager of Big Missouri Mining, writes in protest against the contents of a purported interview published in the *Vancouver Daily Province* of Nov. 18, mentioned in a news note in our issue of Dec. 8, in which Mr. S. G. Blaylock was quoted as having expressed doubt as to the authenticity of the report to which exception is taken. Mr. MacVichie also explains that he is the vice-president of Buena Vista Mining—a subsidiary of Consolidated Mining & Smelting—not consulting engineer, as was erroneously reported.

A. C. HALFERDAHL, writing from Ottawa, Ont., discusses U. S. Bureau of Mines Report of Investigations No. 3047, describing a method of measuring voids in porous material by displacement with water. The report suggests coating the ore particles or pieces with melted paraffin to seal the pores off and make the necessary correction for the paraffin. Then simple displacement gives the voids. "A few years ago," writes Mr. Halferdahl, "I had occasion to determine the apparent gravity of porous material that disintegrated in water. Pieces of the material were coated with paraffin, but air bubbles adhered to the surfaces of the coated pieces under the water. This trouble was overcome by first passing carbon dioxide into the vessel containing the pieces of material for about two hours to displace the air, and then using a dilute solution of sodium hydroxide (0.1 to 0.2 per cent) with a trace of soap, in place of water, to measure the displacement. This procedure effectively overcame the difficulty of adhering air bubbles, and such a dilute solution of sodium hydroxide has practically the same gravity as water." The authors of the aforementioned report do not record any difficulty with air bubbles, according to Mr. Halferdahl, but he states that in his experience they were quite troublesome.

A. E. SMAILL, of Ottawa, Canada, calls attention to the concluding paragraph of a recent article by E. A. Collins, assistant to the vice-president of International Nickel, in which the immense losses sustained in the recovery of copper and nickel, particularly in regard to the iron and sulphur, are mentioned. The figures given for the Copper Cliff mill plant, on the basis of 10,000 tons of ore per day, indicate that the mill feed will carry about 680,000 lb. copper, at 12c., $81,600 per day; 600,000 lb. nickel, at 35c., $210,000 per day; precious-metal content, $40,000 per day; 6,650,000 lb. iron; and 3,500,000 lb. sulphur. The mill tailing will probably carry to the waste dump 20,400 lb. copper, at 12c., $2,440 per day; 42,000 lb. nickel, at 35c., $14,700 per day; 2,050,000 lb. iron; and 510,000 lb. sulphur.

The smelting plant handling the concentrates from the above will send into the air over 3,184,000 lb. sulphur, of which less than 3 per cent will be used to make sulphuric acid. Additions to the slag heap each day will carry the equivalent to about 4,580,000 lb. iron and 51,000 lb. nickel. The losses in precious metal, from ore to matte, will be apparently about $7,000 per day. Some importance is given to the figures for the iron and sulphur losses, by the fact that almost 200,000 tons of sulphur is imported each year, whereas the losses mentioned in the foregoing amount to about 650,000 tons per year. The loss of iron per year, as noted, amounts to 1,210,000 tons, which is well over double the amount represented in the iron-ore imports, Mr. Smaill points out.

High-Alumina Cement Analyses

To the Editor of "E.&M.J.":

In the article on the possibilities of an alumina cement industry which appears in the Nov. 24 issue of *Engineering and Mining Journal* reference is made to tests conducted with the Bureau of Mines 6-ton experimental blast furnace and to preliminary cost estimates based upon the results of these tests. I note you have applied a credit of $17.50 for a ton of pig iron, whereas a credit of $20.00 was allowed in the Bureau of Mines report. In making the estimates, a value somewhat higher than a figure which would apply to pig iron generally was used, because the furnace site was assumed to be along the North Atlantic Coast. If Valley prices of pig iron are applied, the prices assumed for coke, bauxite, and stone should be revised accordingly.

However, the margin of profit is large enough so that small differences in estimates do not change the favorable outlook, from an economic point of view, for making alumina cement and pig iron in the blast furnace. I believe that some doubt exists as to whether the composition of high-alumina cement made in the blast furnace can be controlled as closely as quality of product demands.

Results of tensile-strength tests made by Professor Lang follow:

Sample	Initial Set	Final Set	Strength, 24 Hours	Strength, 7 Days
3,276	1 hr. 40 min.	3 hr. 20 min.	397	238
3,278	1 hr. 35 min.	2 hr. 50 min.	373	317
3,279	7 hr.	23 hr. 40 min.	216	345

In 1927, I submitted three samples of slag made in the Bureau of Mines experimental furnace to Prof. Fred C. Lang, of the University of Minnesota, for testing. These samples analyzed as follows:

	Per Cent			
ample	FeO	Al_2O_3	CaO	SiO_2
3,276	1.23	44.5	47.48	9.8
3,278	1.00	42.5	44.5	8.4
3,279	1.74	44.4	41.4	10.5

The three samples were purposely selected by color to get a variation in composition. The composition of these three samples is not indicative of the variation which would be possible if the blast-furnace charge were regulated to give some specified analysis. In these tests, the charge for the experimental furnace was purposely varied to demonstrate that high-alumina slags varying over a rather wide range in composition can be made in the blast furnace.

The tests show a variation in properties as the composition changes. They indicate the advisability of carefully correlating composition and cementing properties. Once the limits of composition compatible with quality are established, the problem as to how readily these limits could be met in the blast furnace would be simplified.

I hope your article will stimulate discussion that will bring out some additional reasons why the industry has not taken up a project which apparently offers a good financial return.

T. L. JOSEPH,
Supervising Engineer.

Minneapolis, Minn.

F. W. Maclennan, general manager of Miami Copper, and **W. H. Pierce,** president of the Baltimore Copper Smelting & Rolling Company, will be awarded the Saunders medal and the Douglas medal, respectively, by the A.I.M.E., at the meeting in February, 1931.

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Elsing Article on Cananea Prompts Reminiscences

To the Editor of "E.&M.J.":

The review by Mr. M. J. Elsing on "Top-Slicing in the Southwest" recalls to mind certain incidents connected therewith, as follows:

I went first to Cananea in 1906, where I met Mr. (now Colonel) Arthur S. Dwight, then general manager of the Greene Cananea Copper Company. After inspecting underground operations one of us, and I do not now recollect which one, mentioned top-slicing. I was sold on this manner of mining such orebodies as I saw there, having come from Minnesota, where it was in vogue and growing more and more popular, and I either suggested a change or received Mr. Dwight's suggestion of it, with enthusiasm.

It was arranged that Mr. Dwight and the younger Kirk, his mining superintendent, should come to Duluth and proceed to such mines as were best suited for their study. I took them to Ely, where Cap'n John Pengilly was in charge of the Zenith mine and was an expert in top-slicing. Mr. Dwight soon arranged with Mr. T. F. Cole, president of the Oliver Iron Mining Company, to borrow Cap'n Pengilly for a short time, and the latter went to Cananea to install the proposed system. And this system was then initiated.

The fact that Cap'n Pengilly, who was universally liked and admired throughout the Lake Superior iron country, became ill and died of pneumonia, a common and often fatal disease at Cananea, did not add to the peace of mind of those who were instrumental in his going there.

My visit, the first of many to Cananea, was at the instance of Mr. Cole, who, as I was leaving Duluth for Bisbee, said:

"When you are through at Bisbee I wish you'd go over to Cananea and see what is the matter with the Greene."

So, after being around the great mines and the camp for some time, I went back to Duluth and reported to Mr. Cole: "There's nothing the matter with the Greene, excepting Colonel Greene." As I now recall it, the property was then making about 35 million pounds of copper, but earning no profits. This I thought was due to financial operations, which I felt that no manager could correct unless he had absolute power, even over the chief owner.

Negotiations began at once, an option was taken, full examinations were made of the mine and the accounts, the Greene Cananea Copper Company was organized by Mr. Cole and associates, and the property was bought by it.

In those days Colonel Breathett, whom all Southwestern old-timers will remember, ran the Cananea Hotel, up on the mesa above Ronquillo. I well recall my introduction to that hotel. It was a two-story 'dobe structure, and the entire second story, where people slept, was one open room. Cubby-holes in which to pass the night were made by the use of cheese-cloth partitions, about shoulder high. The wire bed springs, hammock shaped, sagged so that in the center they touched the floor. No man could lie in them except on his back. Since the first night there I have needed no proof that sleeping on one's back induces snoring.

Then John Slaughter—an appropriate name—was sheriff of Cochise County. I spent several days, on a later visit, at his ranch listening to Mrs. Slaughter's tales of the Apache days and watching John's expert work with a six-gun. His ranch lay on both sides of the international line—an especially favorable location for any cattle man who wanted to sell on the hoof in the States.

DWIGHT E. WOODBRIDGE.
Duluth, Minn.

Modern Equipment Added to Primitive Plant

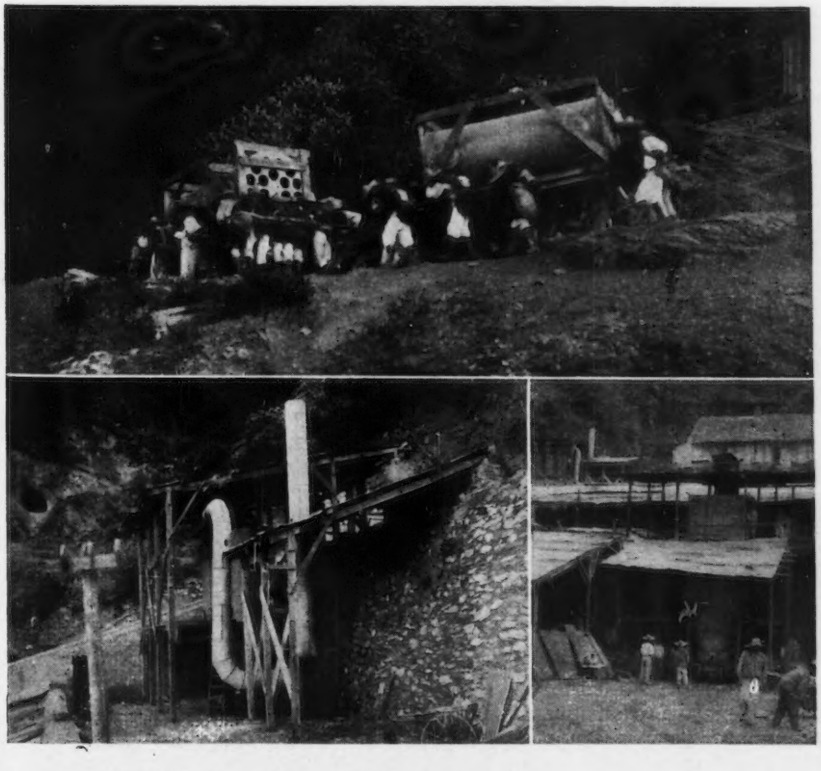
To the Editor of "E. & M. J.":

On a recent trip to Mexico to put in operation a dust-recovery plant I was able to secure some interesting photographs of a small Mexican mine with the crudest kind of equipment, which presents a sharp contrast to the filters. Those responsible for the plant's operations are direct-smelting a lead carbonate ore containing from 31 to 35 per cent lead and from 2 to 2½ kilos silver per ton. The fuel is mostly charcoal, obtained locally by burning scrub oak, but some coke is mixed in with it. The lead bullion is drossed and then refined in a crudely built softening furnace. In the past the lead bullion was drossed, and the furnace was used to make litharge for the pottery trade, the silver residue being cast into bars for the market.

Filters were put in more from a desire to recover the silver in the fume than to remedy a nuisance. They run alternately on smelting and refining, so the baghouse handles all the fume, and all the recovered oxide is moistened and fed back to the blast furnace.

The labor at the mine is the usual run of Mexican peon, and the halftone reproductions of photographs of these laborers carrying the filter equipment over the mountains show a rather unusual method of transportation. The elevation of the mine is about 8,500 ft., and the last 20 miles can be covered only by foot or horseback.

C. W. TRAUGHBER,
Metallurgical Engineer, Dust Recovering & Conveying Company.
Cleveland, Ohio.



Top: Transporting the filter equipment to the property. Left: Filters and exhaust fan. Right: Blast furnace.

OBITUARY

W. W. Widdowson, formerly consulting mining engineer for the Dudley interests in Yavapai County, Ariz., and for the McCracken mine, at Signal, Ariz., died in Los Angeles on Nov. 29.

James M. Porter, consulting mining engineer, of Spokane, Wash., died suddenly on Dec. 5, in his office. He had engaged in professional work for more than 50 years in many Western mining camps. Mr. Porter was 70 years of age, and was born in Roxabel, Ohio.

A. C. Flumerfelt, founder of Granby Consolidated Mining & Smelting, died recently at his home in Victoria, B. C. He was born in Markham, Ont., in 1856. Mr. Flumerfelt, who was a director of Granby Consolidated at the time of his death, opened up the company's original mine at Phoenix, B. C.

William M. Adamson, who had charge of the construction of the United Verde smelter at Clarkdale, Ariz., and the Copper Queen smelter at Douglas, Ariz., died recently at his home in Douglas. He was born in Wisconsin in 1862, and went to Arizona in 1891. Mr. Adamson was three times mayor of Douglas.

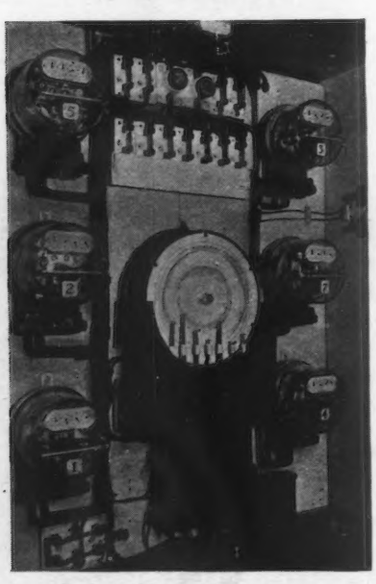
INDUSTRIAL PROGRESS

Automatic Pumping

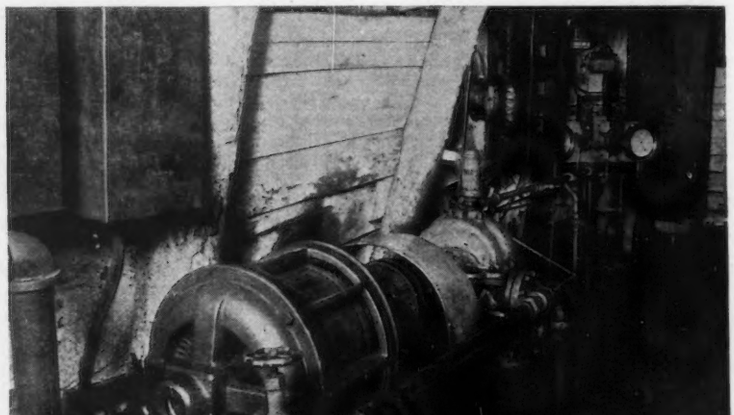
Its Advantages as Told by the Recording Chart

AUTOMATIC control of centrifugal pumping has many advantages. The saving in labor of attendance that it makes possible is likely to be the first that comes to mind. But there are other advantages.

The first step to automatic control was the development of a means of priming centrifugal pumps automatically. The incentive in this instance was the desire to insure safe starting of large units. Discovery quickly followed that the equipment was so reliable that the pumps could be operated without an attendant, and that the starting and stopping could be regulated with precision by use of float switches, pressure regulators, time clocks, and similar means. Next was discovered that one intelligent daily inspection of pump and motor by a mechanic was better than frequent tinkering with them by a less experienced attendant. This was well evidenced in one case, where a 2,500 g.p.m. 400-ft. lift mine pump, automatically controlled, ran 16,025 hours within four years without repairs or replacements of any kind, except packing. This is thought to be a record.



Recorder at Packer Colliery, Lost Creek, Pa. By it was made the chart shown in Fig. 3.



An old centrifugal pump to which automatic control has been applied. It is located at Randolph mine, Port Carbon, Pa. See Fig. 1.

The advantage of effecting the starting and stopping of a pump automatically is demonstrated most forcibly in one of the 24-hour recording charts reproduced in Fig. 1, showing the number of starts and stops made by a 100-hp. centrifugal pump installed in the Randolph mine of the South Penn Colliery Company, Port Carbon, Pa. This pump is provided with automatic control equipment supplied by Barrett, Haentjens & Company, Hazleton, Pa. The pump itself is of a competitive make furnishing an example of how automatic control may be applied to old as well as new pumping stations. During the dry season the pump starts and stops automatically from 40 to 50 times every 24 hours. It draws water from a sump of rather small capacity and runs continuously during the wet season, but is idle part of the time during the dry season when the normal inflow is about one-half of the maximum flow. The pump then makes frequent starts and stops on account of the small capacity of the sump. One may wonder what results would be obtained if the average pump man were required to do this starting and stopping manually day after day for several months. It is quite unlikely that he would bother to start the pump twice every hour. Rather he would throttle the discharge and run the pump continuously, probably without realizing that he was wasting power.

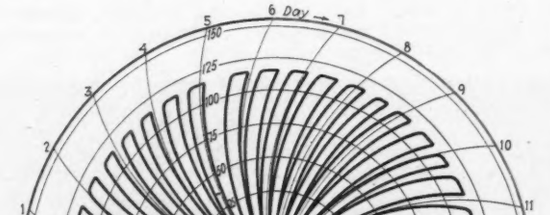


Fig. 1—Half of a recorder chart showing number of starts and stops of 100-hp. automatically controlled pump in Randolph mine, Port Carbon, Pa. It also discloses a power saving not possible with manual control. The remaining half of the chart is similar.

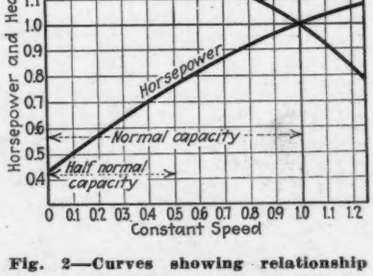


Fig. 2—Curves showing relationship between horsepower-head and capacity in a centrifugal pump.

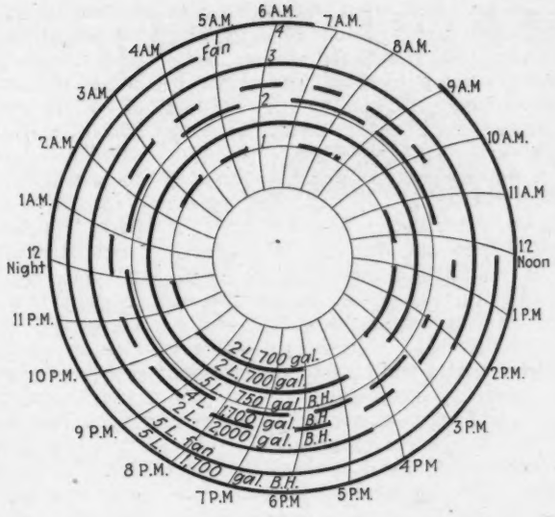


Fig. 3—Chart made by recorder shown on preceding page which shows the actual running time of six automatic pumps and one automatic fan at Packer Colliery, Pennsylvania.

Fig. 1 discloses the saving in power effected by automatic control. Referring to the curves in Fig. 2, it can be seen that at 0.5 of normal capacity the average centrifugal pump develops a head approximately 1.21 times greater than its normal head, so that to reduce the capacity 50 per cent the normal head must be increased 21 per cent. This can be done only by throttling—that is, by partly closing the valve in the discharge line, if the speed of the pump and the lift are fixed.

The curves further show that the average pump at one-half of its normal capacity requires 0.75 of the power at full capacity. At half capacity, it should require only one-half of the power at full capacity, but since three-quarters of the normal power is required, it is very evident that one-quarter is wasted by throttling. In other words, a pump running throttled at half capacity requires 50 per cent more power than it should. If the pump were throttled to one-quarter capacity it would require 0.6 of the normal power instead of 0.25 or 140 per cent more than it should find necessary.

The pump at the Randolph mine consumed 1,000 kw.-hr. in 24 hours' running time. Had it run continuously with the discharge throttled it would have consumed 1,500 kw.-hr. for lifting the same amount of water. Automatic starting and stopping saved in this instance 500 kw.-hr., which, with power at 1½c. per kilowatt-hour, amounts to $7.50 per day. To this, of course, must be added the savings in pump runners' wages, which are governed by local conditions.

If the pump were driven by a variable-speed motor, the capacity could be reduced efficiently by running the pump at reduced speed. It is also possible to reduce the capacity by admitting air into the suction line. This procedure takes less power than throttling, but it cannot be recommended, because rapid corrosion of the internal pump parts may take place, especially if the water handled is acidulous.

Fig. 3 shows a chart taken from the recorder shown on the preceding page. This instrument records the actual running time of six automatic pumps and one automatic fan at Packer Colliery, Lehigh Valley Coal Company, Lost Creek, Pa. Fig. 4 shows the regularity of the starts and stops made by an automatic pump at the Pine Hill Coal Company, Minersville, Pa. Automatic control is said to have saved about $3,600 in a ten months' period at the latter station.

■

To Consolidate Operations at One Plant

Within the next few months, the Fuller Lehigh Company, a subsidiary of the Babcock & Wilcox Company, will move its manufacturing operations and executive offices from Fullerton, Pa. Its manufacturing is to be consolidated with that of Babcock & Wilcox at the latter's Barberton, Ohio, plant. The executive offices will be at 85 Liberty St., New York.

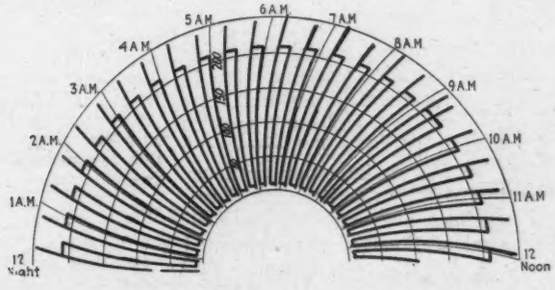
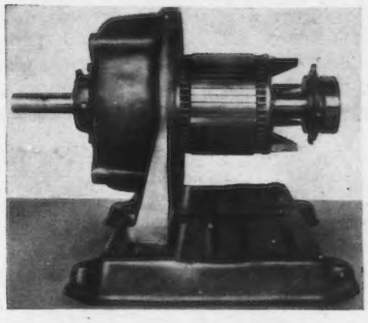


Fig. 4—Half of another recorder chart showing regularity of and stops made by an automatically controlled mine pump of the Pine Hill Coal Company, Minersville, Pa. The remaining half is similar

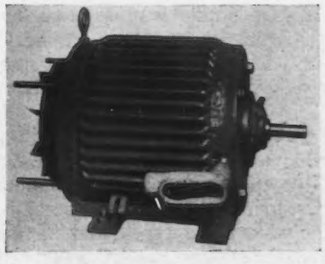
Some New Motors — Two Novel Crushers—Other Equipment

THOSE concerned with selecting, installing, and operating motors and generators will be interested in the new book of Motor and Generator Standards just published by the *National Electrical Manufacturers' Association*, 420 Lexington Ave., New York. It contains much information for reference purposes on application and selection, ratings, test performances, construction, guarantees and business policies, and also comprehensive lists of definitions and abbreviations of terms pertaining to motors and generators. It may be had at $1.50 per copy by applying to the Association.

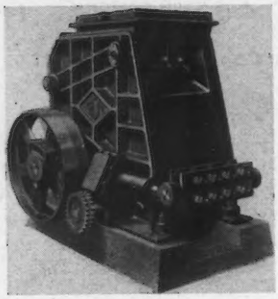
What is said to represent a radical departure in motor design has been developed by the *Ideal Electric & Manufacturing Company*, Mansfield, Ohio, in the form of a so-called unit type of construction, featuring a complete series of motors. These are so designed that all load shocks and strains are carried directly to the motor support. The only mechanical load on the stator is the motor torque. When the front end bracket and stator are removed, the pulley end-bearing bracket remaining bolted to the base will still support the rotor and gear, pulley, or other connections to the driven machinery, as shown in a cut presented herewith. The



Front end bracket and stator of this new motor are removed showing rest supported by remaining bracket



A new induction motor, totally inclosed and fan-cooled



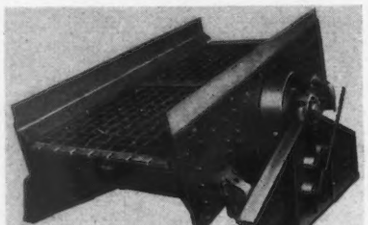
This 6x16-in. jaw crusher will handle 9 tons of 6 in. (maximum) feed per hour, when set to ¼ in.

motors are built with standardized rotors and stators, interchangeable for all types. Details are given in Bulletin 200. . . . Another new motor is of the induction type, totally inclosed and fan-cooled, announced by *Lincoln Electric Company,* Cleveland Ohio. It is designed so that its temperature rise is much less than the allowable rise for motors of this type. The design includes arc welded-steel construction, double-sealed ball bearings, and a removable cover to facilitate cleaning of the radiating surface. The motor is shown on the preceding page with the cover removed.

A cut shows a jaw crusher (GCM) made by the *Guest Crushing Machines, Inc.,* Los Angeles. The crusher uses the yielding jaw principle, and has roller bearings throughout. After material is crushed to size, the crushing action is downward for an eighth of each revolution, giving added impetus over that of a free-falling body, thus accelerating the passage of sticky material that would ordinarily clog a crusher. The crusher may be used as a primary or secondary, or as both. The 6x16-in. size shown in the cut will handle 9 tons of rock per hour (maximum feed 6 in.) when set to ¼ in., delivering a uniform crushed product of $\frac{5}{16}$ in. . . . For about a year *Stedman's Foundry and Machine Works,* Aurora, Ind., has been in the swing-hammer mill field with a complete line of swing and ring hammer crushers, grinders, and pulverizers. The line includes three types and 25 sizes of mills, the power requirements ranging from 5 to 250 hp. Type A mill, a general purpose machine, is made in nine sizes and is especially designed for fine and semi-fine grinding and pulverizing. To date, it has handled over 100 different materials. Two-stage reduction is used, the shattering being done in suspension. The finished grinding or sizing is done after gravity has been overcome. This secondary reduction step takes place between the face of an adjustable grinding plate and the hammer tips, this giving larger capacities and a more uniformly finished product with lower maintenance cost. Type B machines are used for preliminary or secondary crushing and are made in sixteen sizes, ranging from 15 to 250 hp. The larger sizes will handle 18 to 24 in. cubes of limestone, gypsum, asphalt, rock shale, and similar materials, reducing to ¾ in. and under in one reduction. This type can be had equipped with either swing or ring hammers.

Robins Conveying Belt Company, of New York, is making the screen shown in the cut, a Mogul Gyrex. It will screen out material as large as 6 in. and handle pieces up to 20 in., making it useful as a scalping or screening unit for hand-mucked ore; also to follow the primary crusher in both ore reduction mills and crushed-stone plants. For ordinary installations a 7½-hp. motor is sufficient, but for cold weather a 10 hp. motor is recommended. . . . A revision of the American Standard Safety Code for the Installation of Pulverized Fuel Systems is announced by *American Standards Association.* The original was approved in 1927. Rapid increase in the use of pulverized fuel is responsible. The standard is a part of a comprehensive project for preventing dust explosions. Copies may be had at 5c. each by application to the Association, 29 West 39th St., New York.

Waste-heat boilers of a new kind have



This vibrating screen is useful as a scalper on hand-mucked ore

been developed by the *Foster Wheeler Corporation,* 165 Broadway, New York. They consist of heating elements built of seamless steel tubes covered with cast-iron extended surface, reamed to size and shrunk on the heating tubes. They are more compact per square foot of heating surface than has hitherto been possible. The first installations were made to take exhaust gases from Diesel engines, the boilers acting as mufflers in such service. When operated with waste-heat gasses not exceeding 800 deg. F., it is not necessary to bypass the boilers for protection, even when dry. Thus the boilers may be run as flash boilers, steam production being controlled by setting the feed valves for the desired steam quantity. . . . The *Babcock & Wilcox Company,* New York, is marketing built-up crucibles made of B. & W. No. 80 refractory material for use in induction furnaces for melting cast iron and special alloys. These crucibles are made of tongued-and-grooved sections of tile, cemented with B. & W. No. 80 cement. The crucible is set into the furnace coil and the space between coil and crucible is packed with mica or asbestos paper. Inside, the crucible has a rammed lining of No. 80 crucible cement, by renewing which lining every 10 or 15 melts, it is possible to get 150 to 200 melts from one crucible.

Rheocrete (Northern) Ltd., Trafford Park, Manchester, has been organized in Great Britain to produce "Rheocrete," a pumice-rock building material. The company is a subsidiary of F. McNeill & Company. The possibilities of pumice rock as a building material have been recognized for years. Entirely free from foreign matter, Rheocrete pumice forms an excellent base for concrete building and flooring materials. It is mixed with rapid-hardening cement — nine parts of graded Rheocrete to one part of cement—watered twice daily for three days and left three weeks before any covering is put on. This gives a concrete weighing 40 lb. per cubic foot at most. It is said to be durable, fireproof, sound-absorbing, and to avoid condensation troubles. It can be easily cut and holds nails without the use of plugs. It does not act chemically on steel or iron nor discolor plaster or wall paper. . . . A new acid-resistant material known as "Mineralead" has been developed by the *Knobbe Laboratories, Inc.,* 114 East 32d St., New York and is being produced by the Atlas Mineral Products Company, Mertztown, Pa. It is intended for application in fluid or plastic form for use as a jointing compound in bell and spigot cast-iron water mains and for lining tanks made of concrete. It may also be used for pointing joints in acid-proof masonry. The material is marketed in the form of 10-lb. ingots. It has a melting point of 113 deg. C. and in use requires only to be melted and applied either in the fused or plastic state. It has a base of sulphur, which is said to give it almost complete resistance to most acids. It is not recommended for temperatures above 100 deg. C.

Following the introduction some time ago of its standard flexible coupling, the *Poole Engineering & Machine Company,* Baltimore, Md., has brought out a less expensive model for light and medium duty. This is known as the medium-duty type and is intended specially for driving pumps, fans, small compressors, small generators, blowers, conveyors, elevators, and other medium-duty machinery.

Flexible coupling for medium duty

NEWS OF THE INDUSTRY

Propose Maryland Unit for Bureau of Mines

To meet the need of the U. S. Bureau of Mines for a laboratory near Washington, D. C., Senators Tydings and Goldsborough, of Maryland, have introduced a bill to appropriate $350,000 for the erection of a building on the campus of the University of Maryland, about 8 miles from the capital. The new station would occupy a commanding site on a tract of 20 acres that the board of control has agreed to cede for the purpose because of its desire to obtain for the state university this added contribution to its prestige. As Republican and Democratic members of the state delegation in Congress have united in support of the project, no opposition is anticipated other than the argument which may be advanced by the Budget Bureau that it conflicts with the President's policy of strict government economy. It is understood, however, that Mr. Hoover favors the plan, and no objection to it has yet been interposed by Secretary of Commerce Lamont.

Advocates of the plan point out that nothing is allotted to the Bureau of Mines in the $115,000,000 program of public works recently voted by Congress and inquiry to state officials discloses that no allocations of any size have been made for public building construction in southern Maryland. The project falls naturally into the administration's program of affording relief by providing employment, as the building will be of a simple type, in which at least 50 per cent of the expenditure will be for labor.

Returning the Bureau of Mines to the jurisdiction of the Interior Department and transferring it bodily from Washington to Salt Lake City are advocated in a bill introduced by Senator King, of Utah. Senator Smoot has put forward a proposal for appropriating $1,000,000 for the erection of a federal building at Salt Lake City to house the field services of the Bureau of Mines, Geological Survey, the General Land Office, the Census Bureau, and the Bureau of Foreign and Domestic Commerce. This building would be located on land to be donated by the University of Utah.

■

Suit Filed Over Tailing Used in Building Michigan Road

J. J. Byers, of Houghton, Mich., owner of the tailing deposit at the Mass Consolidated mill site, on Keweenaw Bay, near Baraga, Mich., has filed a suit for $39,710 against the Michigan Highway Commission and the Baraga County Road Commission for stamp sand taken for highway purposes. About 180,500 cu.yd. of sand was used, on which a value of 25c. a cubic yard has been placed, according to Mr. Byers, who purchased the Mass mill in 1926. He has virtually scrapped the mill. In bringing the suit, Mr. Byers estimates that the copper content of the tailing is about 5 lb. per cubic yard, and he says it makes an excellent road material. About 5,000,000 to 7,000,000 cu.yd. of tailing are still contained in the deposit.

■

Commerce M. & R. Raising Output to Record Levels

Commerce Mining & Royalty has doubled its production of zinc and lead concentrates in the Tri-State district during the year and, before the regular Christmas shutdown, was producing at a rate never before attained by a single company in the history of the Tri-State district. Output of the company for the first part of December was about 2,300 tons of zinc and lead concentrates a week. Largest single production of zinc concentrates ever reported by a company in the district in any year was made by Federal Mining & Smelting in 1926, when total zinc shipments were 77,089 tons. Commerce shipped 69,196 tons of zinc concentrate in the first 48 weeks of 1930.

The latest Commerce property to be opened is the See Sah mine, on the Cecil Quapaw allotment. Ore is being milled at the rejuvenated Jay Bird mill. The property is said to be one of the richest ever opened in the Oklahoma field. Plans of the company have reached a stage where it is said that production can be increased to 3,000 tons of zinc and lead concentrates a week within less than sixty days. The increased production would be derived by increasing the running time of the Bird Dog mill from ten to twenty hours daily and mining of ore from the Jay Bird and Bennie mines for treatment at the Blue Goose mill. The ore from the Pelican mine is now being diverted to the Bird Dog mill, and other leases may soon be hooked up with this mill.

Nothing new has developed in regard to the sale of the Commerce properties to Eagle-Picher Lead. Definite action is expected in this connection in the next six weeks.

Cerro de Pasco Employees Return to Properties

On Dec. 14, after an absence of about a month, the American, British, and foreign employees of the Cerro de Pasco Copper Corporation returned to their various camps up in the mountains in the Department of Junin, Peru. The Peruvian government has assured the corporation of ample military protection for all employees.

Cable reports received by the New York office since the return of the foreign staff to the properties indicate that operations can be resumed with reasonable promptness. The mine pumps have been kept running, so that no serious damage to the mines has occurred. Plants, buildings, equipment, residences, and contents are intact, having been guarded by government police during the absence of the foreign staff.

Only two copper reverberatory furnaces will be started and operated at present and no blast furnaces. The starting of the Casapalca mill and the lead furnace at Oroya will probably be deferred for the present.

In addition to resuming production of copper, construction on the new 40,000-hp. hydro-electric plant on the Mantaro River at Malpaso will be resumed, possibly at a reduced rate sufficient to keep pressure and diversion tunnels from deteriorating. The same program may be adopted with respect to the work on the Morococha drainage tunnel at Mahr. Resumption of work on the new Bellavista concentrator near Casapalca may be entirely suspended for the present.

■

Roasters Limit Boliden Output

Production of copper from the Boliden smelter of Skelleftea Gruv Aktiebolag, in northern Sweden, is about 120 metric tons a month. Output has been limited by insufficient roaster capacity. The blister copper produced carries about 33 oz. of gold per ton, making the mine more of a gold than a copper property.

Oroya metallurgical works of Cerro de Pasco, Department of Junin, Peru.

Greene Cananea Completing Reconstruction Program

Remodeling and reconstruction of the metallurgical and power plants of Greene Cananea, at Cananea, Sonora, Mexico, have been virtually completed. This program has been under way for the last two and a half years and is designed to provide for economical treatment of the new Colorado copper orebody, discovered and developed at the property within the last few years.

Among the units that have now been completed are the coarse-crushing and sampling units; the grinding sections of the three concentrator units, each of which has a daily capacity of 1,000 tons of ore; two waste-heat boilers for the reverberatory furnace at the smelter; and the Ojo de Agua pumping plant, which supplies potable water to the town as well as the company operations. Production will not be affected by completion of the construction program, but will be continued on the curtailed basis adopted as a result of current low copper prices.

■

Seek Radium Ore in Arizona

The Smithsonian Institution is preparing to explore a part of the Upper Verde mining district near Prescott, Ariz., for radium ore. A highway has been constructed from Puntenny to the camp. Diamond drilling will be started soon. The aim of the institute is to find radium in sufficient quantities to cheapen the price so that the benefits of the rare element will be more universally available. Operations have been carried on in Colorado, Wyoming, and Nevada, but only two fields have been located, one in Colorado and the other in Wyoming.

■

California Mining Association

At the annual meeting of the Mining Association of California, at Sacramento, on Dec. 6, resolutions similar to those passed at the recent meeting of the northern chapter of the organization were adopted, looking toward a revival of gold mining within the state. Among the steps which were advocated were: separate classification of mine labor for compensation insurance; repeal of federal taxes on gold production; opposition to Norbeck bill; ceding of mineral rights in public lands to the state; lower state taxes; repeal of corporate securities act; and extension of highway facilities on the Mother Lode.

■

Ahumada Exploration Continues

Exploration is being continued on the No. 7 level of the Ahumada Lead property, near Los Lamentos, Chihuahua, Mexico, in the hope of striking a silver-lead deposit parallel to that from which most of the production has been obtained. The company is losing money steadily at the current low lead price, and has been forced to abandon the No. 8 level because the cost of keeping it pumped out is too great. However, the management has confidence in the mine and, because of the fact that its continued operation is essential to the Los Lamentos district, work will probably be continued for some time in the hope either of a new strike or an improvement in lead prices. Production for the first ten months of 1930 was 7,900,000 lb. of lead. For the entire year it is expected to be about 2,500,000 lb., compared with more than 12,000,000 lb. in 1929. Most of the ore is shipped to the American Smelting & Refining plant at El Paso, Tex., where it is used for flux, but some is also shipped to the company's Mexican smelters.

Headframe at the N'Kana property, which was included in the recent merger of Rhodesian copper mines

■

Panama Nearing Production

Duncan Elliot Alves, who is chairman of the board of Panama Corporation, reiterated at a recent meeting of the company that it is a purely commercial undertaking. The company purposes to reabsorb Panama No. 1, El Mineral, and Cana, all of which had been floated off as separate companies. Hugh Marriott, one of the directors, stated that the Remance mine, now controlled by Panama No. 1, would yield a profit of £7 per ton of ore, the chief value being gold. Production is expected to start at this property, as well as the Sabals and El Mineral alluvials, within the next few months.

■

Trepca Tunnel Record Set

During November, a total of 876 ft. was driven in the new Trepca Mines tunnel at Zvecan, Yugoslavia, a new record for the tunnel and very close to the world's record for similar work. The tunnel is now in 7,290 ft. Production at the company's mill has been increasing slowly. During November the average daily tonnage was 641 tons, although capacity was rated at 500 tons. Lead concentrate produced during the month amounted to 3,570 tons, assaying 73.9 per cent, and zinc concentrate, 2,656 tons, assaying 48.9 per cent. Though the plant was started with inexperienced labor at a time of low metal prices, profit from the first 42 days of operation, Aug. 20 to Sept. 30, was £2,221.

Geophysical prospecting and diamond drilling are being continued. The company has secured an option on the adjoining Breskovo area, 4,000 sq.km. A new orebody has been discovered in the Meljenica orebody.

Rabbit Hole Location of Nevada Gold Find

What the Associated Press describes as a rush of "hundreds of men and a few women" has been started by the discovery of gold at Rabbit Hole, about 40 miles north of Lovelock, Nev. Two brothers, Charles and James Scossa, are responsible for the find, which is described as extremely high grade. Twelve sacks of the ore, weighing 90 lb. in all, are described as being worth "several thousand dollars." The district has been prospected in the past, but Lovelock is the nearest producing camp.

■

Double Pioneer Gold Capacity

Capacity of the 100-ton Pioneer Gold concentrator, in the Bridge River district of British Columbia, will be doubled, according to the company's plans. In November the company produced $51,500, indicating a grade of almost $20 a ton, and, for the entire year, production will amount to between $275,000 and $300,000, nearly all in gold.

Development at the property has now opened up the orebody for 800 ft. on the 1,000 level, with widths ranging from 3 to 5 ft. On the 875 level, an extremely high-grade section has been opened for a distance of 80 ft. A parallel vein, cut in sinking to 1,000 ft., and again in crosscutting to the main vein at that depth, has not been thoroughly explored as yet. The company has nearly completed a 1,200-hp. hydro-electric power plant, which will furnish power for the enlarged concentrator.

■

R.M.C. Issues First Report

Rhodesia Minerals Concession, Ltd., reorganized a year ago, has issued its first annual report. The prospecting-geological force on the concession, 150 miles south of N'Dola, has now been increased to eight geologists and one prospector. Up to the end of September, 1930, a total of 1,665 square miles had been traversed systematically. J. Austen Bancroft, consulting geologist, says the overlying Broken Hill series, comprising limestones, shales, sandstones, and quartzites, are in many localities so highly metamorphosed that they cannot be distinguished from the Basement Schists. In other areas they are very similar to what would be expected of the copper-bearing Bwana M'Kubwa Series—if the latter were subjected to intense metamorphism.

■

Seattle Mining Institute to Meet

The College of Mines, University of Washington, Seattle, Washington, announces that its third annual Mining Institute will be held Jan. 19 to 25, 1931. The sessions are open to all persons interested in any phase of the mining, metallurgical, or ceramic industries. No fees are charged for entrance. Last year 240 persons attended the various meetings. Those interested may receive further information concerning the forthcoming conferences by writing to the Dean, College of Mines, University of Washington, Seattle, Wash.

Develop Bodie With View to Large-Scale Operation

Development work at the old gold-mining camp of Bodie, Calif., is being conducted with a view to possible operation on a large-scale, low-grade basis, similar to that at Alaska Juneau, a supplementary report issued by Treadwell Yukon reveals. As a result of surface examination, 1,533,300 tons, averaging $1.80 in gold per ton, have been proved, and a 400-ton mill is now under construction to handle this material. Power-shovel sampling of the surface on a wholesale scale is under way, with the expectation that extension of the surface areas of low-grade ore will be discovered. The plan is to use the 400-ton mill to test ore from the power-shovel sampling. A block of ground containing 50,000,000 tons will be thoroughly sampled.

In addition, work on the 700 level of the Red Cloud shaft has resulted in the development of several oreshoots. The company estimates that 56,300 tons of an average grade of $20 in gold and 11 oz. of silver per ton has been proved. A twenty-stamp mill is being rehabilitated and will handle the ore from this shaft. Estimated profits from this ore are $10 a ton.

Another low-grade gold property on which the company is working is the Birum group, formerly owned by Imperial Mines, near Battle Mountain, Nev. The average grade is expected to be about $3 in gold per ton. Sampling and underground exploration are in progress. In California, the option on the Nidiver property has been retained.

At the company's Errington mine, Sudbury, Ont., exploration is being continued at 1,500 ft. No ore has yet been encountered. Milling operations in the 300-ton pilot plant have been temporarily discontinued. Operating profit from the Wernecke silver-lead mines, in Yukon Territory, is expected to total $400,000 in 1930. The Tybo unit, in Nevada, is not operating at a profit, but earnings from zinc-lead production are sufficient to take care of underground exploration. Mill operation is restricted to 160 tons daily. On the 860 level, ore has been cut for a width of 18 ft.

Exploration of the complex zinc-lead-copper deposits at Taku River, B. C., failed to yield sufficient encouragement for a continuation of work. At West Hill, B. C., work is being continued on a lead-zinc prospect. Options on the Copper King group, in Idaho, have been abandoned.

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Coeur d'Alene Mines Curtail

Hecla Mining and Federal Mining & Smelting, two of the three large producers in the Coeur d'Alene district of Idaho, second most important lead-producing area in the country, have followed the example of St. Joseph Lead and National Lead, southeast Missouri operators, in cutting output. They are putting their mines on a five-day week basis, with the object of reducing production by about 20 per cent. For the last few months, both companies had been operating at a normal rate in Idaho, although Federal has curtailed production from its Tri-State properties for some time, and is now reported to have closed virtually all its mines there. Day-rock Mining, one of the few remaining small shippers in the district, is also decreasing its output.

Bunker Hill & Sullivan, the third large producer in the Coeur d'Alene district, will not make any change in its present production quota. Development work is being continued and an additional 200 ft. of depth is reported to have been added to the new high-grade Sullivan orebody, which has been opened for 400 ft. on the No. 9 level and for 500 ft. on the No. 6 level.

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Santa Gertrudis Reserves Drop

Ore reserves at the Santa Gertrudis properties, Pachuca, Hidalgo, Mexico, were estimated on June 30 at 880,700 short tons, averaging 1.6 dwt. of gold and 20 oz. of silver per ton, a drop of about 78,000 tons from the estimated reserves on June 30, 1929. As 584,770 tons was extracted during the year, development put in sight about 506,000 tons. The grade is considerably higher, however, so that the metal content of the reserves showed an actual increase during the year from 14,650,000 oz. of silver to 17,575,000 oz.

Intensive exploration was continued, 43,354 ft. of development work being driven. Development of the known vein systems of the Dos Carlos mine has yielded better results than purely exploratory work. A new level, No. 23, has been opened up 165 ft. below the No. 22. Ore of good grade has been found, but indications are that payable mineralization does not persist much below this depth. In the west end of the mine, ore of exceptionally high grade is being developed below the No. 19 level.

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Pecos Water Flow Increases

An increase is reported in the water flow at the Pecos zinc-lead mine of American Metal, at Glorieta, N. M. Development work on the Nos. 9 and 10 levels is responsible. The company recently installed a new 1,000-g.p.m. pump on the No. 10 level, and, although its capacity is not yet taxed, an order for an additional unit of the same size is being considered. In the meanwhile, several smaller pumps are available.

The daily tonnage now being handled in the mill is about 500 tons. At this rate, operating expenses are being met. A small and, it is hoped, temporary wage cut was put into effect recently. Development has been curtailed and is now centered on the drifts being extended north and south on the Nos. 9 and 10 levels. The drifts north and east will explore the Evangeline orebody and the new ore indicated by drilling east of it. On the No. 10 level, drifting is proceeding south of the main shaft, with results up to expectations.

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Potash Minerals Cut by Drills

Drill holes Nos. 17 and 18, put down by the U. S. Bureau of Mines in its campaign of exploration for potash in New Mexico and Texas, cut beds containing carnallite and sylvite, two of the more important potash minerals extracted in Europe, as well as polyhalite. The holes were 50 miles apart, in Lea County, N. M., and Loving County, Tex. None of the beds encountered are considered of present commercial importance.

"Good Old Days" Recalled by San Francisco Section

Echoes of past mining history, the Comstock, Leadville, Bodie, California gold dredging, Broken Hill and metallurgical plants in the San Francisco Bay region featured the annual reminiscence meeting of the San Francisco section of the A.I.M.E. on Dec. 9, 1930. C. N. Schuette directed the meeting in his shirt sleeves, and members and guests likewise shirt-sleeved the meeting. A trio of whiskered fiddlers in hard hats and red shirts created musical static that re-echoed the pleasures of the old-time mining camps. A mellow punch of unknown composition softened the dignity of all, and beans and sirloin roast added fuel to the fire.

Although hard to believe from his polished exterior, Grant H. Smith claimed to have crashed the Comstock in 1867, and in the smoothest address that also belied his claims to advanced maturity, he told about the hectic days of the famous mines; sketched the personalities of Mackay, Fair, O'Brien, and Flood; dilated upon the stock-market booms and their pathetic crashes; explained the influence of the large production of silver and gold upon the monetary machinery of the world, and concluded with the statement, attributed to T. A. Rickard, that "Comstock influence upon mining history is second only to that of Potosi."

Henry E. Wood related anecdotes of early Colorado history and of Leadville, and told about his unsuccessful prospecting and his first job as an assayer, as well as the development of his ore-testing business, and a fishing story now and then.

Jim Cain, of Bodie, claimed to have lived in Bodie for 51 years, but although this was accepted by his audience, time has left him bright eyed and cheerful, easy-speaking and interesting. Jim radiated happiness, for F. W. Bradley and his associates have undertaken the work of reopening the shafts at Bodie. He contrasted the early days, when the wood bill of three mines amounted to $825 per day, with the present use of electrical machinery. He told about the Fortuna vein, with its 6-in. thickness of almost solid gold, and about the tough guys who "shot it out" on the bleak streets of Bodie.

W. P. Hammon, unable to be present, was ably represented by Newton Cleaveland, who reviewed the high points in gold-dredging history. Abbot Hanks began his metallurgical history by telling how the early assayers made gold coins to satisfy the local money need before the U. S. Mint was established at San Francisco in 1854, and how T. H. Selby, a pioneer hardware merchant, established the Selby Smelting Works, and the growth of the metallurgical business about the bay region was methodically described. E. H. Nutter switched the audience back to Bodie and related the story of the superintendent who was unable to get any sleep, so frequently was he called upon to supervise the clean-up of the stamp mortars choked with gold. "There it lay, just like corn, all about the stamps and dies," he said. From Bodie he skipped to Telluride and told about labor difficulties and high-grading. Then on to Gaines Creek, in Alaska, where he and his associate found a disappointment. Broken Hill and the start of flotation were dilated upon.

Many were there. The place reeked with tobacco smoke. Some glasses had been tipped over. But, the tedium and casualness of life had been dissipated by the romance of mining.

Advocates of Percentage Depletion State Case Before Congressional Hearing

ALTHOUGH mine operators are divided on the proposal, no opposition from the industry was voiced at the hearings in Washington on Dec. 9-12 before the Joint Congressional Committee on Internal Revenue Taxation, to basing mine depletion allowances on 33⅓ per cent of net income before depletion, after depreciation, where such allowances would not be less than if computed on the basis of cost or of value as of March 1, 1913.

The attitude of operators who still desire to hold to the discovery depletion provision of the present law was revealed in a letter read into the record by Alex. P. Ramstedt, of Wallace, Idaho. In it Paul Armitage, chairman of the general tax committee of the American Mining Congress, suggested to J. F. Callbreath, the secretary, under date of May 9, 1930, that Armitage's address in opposition to percentage depletion as a substitute for discovery value should not be printed in the proceedings of the annual meeting of the congress a year ago.

A. G. Mackenzie, of Salt Lake City, stated on behalf of the congress that the organization believes that any effort to uproot the present law will create confusion, and insists that no relief measures should be forced upon any part of the industry not seeking relief. The present law, said Mr. Mackenzie, should remain applicable to as much of the industry as is satisfied with it, and changes in the law should be confined to those cases in which inequities may exist.

Questions directed to other witnesses during the course of hearings indicated that the members of the committee are not in favor of setting up percentage depletion merely as an optional alternative to the present provisions of the law. Asked by Representative Treadway for his opinion of two types of law, D. A. Callahan, president of Callahan Zinc-Lead, of Wallace, Idaho, replied that that is what a part of the mining industry is complaining about now; the present law benefits one and discriminates against others.

The percentage depletion method was urged as a means of simplifying present administration by avoiding mine valuation and correcting inequitable distribution of the tax burden as between mine and mine by computing the tax on net income, a basis reflecting the mine's ability to pay. The witnesses who appeared to support the proposed amendment included Dr. L. C. Graton; Mr. Ramstedt; James C. Dick, mining engineer, of Salt Lake City, former head of the natural resources division of the Bureau of Internal Revenue; Stanly Easton, of Bunker Hill & Sullivan; F. G. Hamrich, of New York, representing American Smelting & Refining and other companies; James F. McCarthy, of Wallace, Idaho, of Hecla Mining; Mr. Callahan; W. Earl Greenough, of Mullan, Idaho, of Atlas Mining, and Clinton H. Crane, of New York, president of St. Joseph Lead.

A. Scott Thompson, of Miami, Okla., counsel for the Tri-State Zinc and Lead Ore Producers' Association, endorsed percentage depletion with the proviso that operators should not be deprived of allowances already established. W. B. Reed, counsel for the National Coal Association, stated that there was substantial unanimity of opinion in that organization for a percentage depletion rate of 33⅓ per cent, provided it protects present basis of cost, or 1913, value. W. J. Friedman, of Chicago, representing the Building Stone Association of Indiana, the Indiana Limestone Company, and others, said that a fixed rate of depletion per cubic foot of stone would be the most satisfactory to them, but that, as this might not be acceptable to other mining interests, they are willing to agree to any other method which would provide a fair and equitable basis for establishing depletion allowances. Dr. R. C. Allen, representing Lake Superior iron mines, was scheduled to appear, but withdrew without making any statement.

Dr. Graton's testimony to the effect that, in the long run, percentage depletion would be of greater benefit to both the taxpayer and the government than any present method raised the question why those in favor of this method do not advocate its application without reservation as to cost, or 1913, value. Dr. Graton replied that if it were possible to start anew in establishing a system of mineral taxation, with no past to complicate the present and future, as in Canada, he would urge percentage depletion as the sole method of determining deductions. But there are companies, he explained, that in good faith have received depletion allowances from the Bureau of Internal Revenue after much effort and hardship which he was not prepared to described as unfair in any case.

To a question as to what proportion of the mining industry favors percentage depletion, Mr. Graton replied there was no way of obtaining a real answer. Regarding the probable effect of percentage depletion allowance on government revenues, he said that a report prepared in the Bureau of Internal Revenue estimated the reduction in taxation of metal mines at 1½ per cent, amounting to $200,000 in 1926, with a gradual curtailment of this loss of revenue in subsequent years.

W. E. Hope, Assistant Secretary of the Treasury, stated that the Treasury Department does not consider the present system as "entirely ideal" and is prepared to consider percentage depletion with an open mind, but Benjamin H. Bartholow, who recently succeeded E. C. Alvord as special assistant to Secretary Mellon, presented a vigorous argument against a further departure from original investment as a basis for computing allowances for depletion. Though it was necessary "for constitutional reasons" to substitute for original investment fair market value as of March 1, 1913, said Mr. Bartholow, discovery value is a special tax privilege accorded to the mining industry by Congress under unusual circumstances. He declared that the Treasury Department must have substantial ground for agreeing that such privilege should be further extended. Mr. Bartholow explained that the discovery depletion provision was authorized by Congress as a reward for discovery of mineral resources.

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Fresnillo Reduces Costs at Oxide and Sulphide Units

Costs in both the oxide and sulphide units of the Fresnillo Company, operating at Fresnillo, Zacatecas, Mexico, were greatly reduced during the last fiscal year, publication of the company's annual report reveals. At the oxide unit, the cost per ton of ore treated dropped from $2.31 in the previous year to $1.80, and in the sulphide unit, from $9.62 to $8.49. These figures include mining, milling, shipping, selling, and general expenses. Production of oxide ore is now about 2,000 tons daily, and of sulphide ore about 700 tons daily. Reserves of oxide ore are only 1,265,000 tons, averaging 5.95 oz. of silver and 0.13 dwt. of gold per ton, a grade which yields little or no profit at current silver prices.

A very large increase was made in the sulphide reserves during the year, despite the extraction of a record tonnage, and the total of positive and probable ore on June 30 was estimated at 968,194 tons, compared with 807,006 tons at the end of the previous year. The average grade is 9.3 per cent lead, 9.8 per cent zinc, 0.6 per cent copper, 10 oz. of silver, and 0.4 dwt. of gold per ton. Hugh Rose, manager of the company, considers the outlook favorable for further large additions to these reserves. The company is engaged in development work on the 470-, 515-, and 560-m. levels, none of which were included in estimating reserves, as the orebodies have been fully defined only above the 425-m. level.

Shipments of raw iron concentrate have been suspended, because of the low price of silver, but the resulting lower recoveries of the precious-metal content of the sulphide ore have been more than offset by recently improved recoveries in the lead and zinc sections.

The company has taken a 60 per cent interest in the Cia. Minera de San Jose, which is treating a patio tailing deposit 6 miles east of Fresnillo. This deposit is estimated to contain at least 330,000 tons averaging 0.4 dwt. of gold, 4.4 oz. of silver, and 1.37 lb. of quicksilver per ton. Capacity of the lixiviation plant is 5,000 tons monthly. Working costs are low, and with present quicksilver and silver prices, a profit of $1.50 per ton, or $7,500 monthly, is expected.

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Tri-State Promises Support for Western Meeting

Definite assurances were given F. C. Dike, governor of the Western division of the American Mining Congress, that the mine operators and business men of the Tri-State district would give the necessary financial support to hold the 1931 joint convention of the Western division and the Western regional meeting of the A.I.M.E. in Joplin, at a meeting held recently.

An executive committee composed of Mr. Dike, F. C. Ralston, president of the Joplin Supply Company; Charles A. Neal, Miami, president of the Tri-State Zinc and Lead Ore Producers' Association; Jesse G. Starr, Joplin, president of Quinton Spelter, and James E. Harsh, Joplin, president of the Empire District Electric Company, was appointed to work out plans for the convention.

BRIEF NOTES

Alta Tiger Mining. A compressor is being installed at the company's Jackson mine, near Montello, Nev. Development of the 210 level is planned. Recently a carload of ore was shipped from the 170 level. Smelter returns showed an average assay of 29 per cent lead and 6.8 oz. of silver to the ton. Lester Rankin is manager.

Calaveras Development. This company, a Nevada corporation, has taken over the Ford property, near San Andreas, Calif. A 100-ton mill will be built to handle the ore, according to the company's present plans. I. E. Selix is president and J. E. King is superintendent.

Calumet & Arizona. A power cable leading to the pump station on the 2,200 level of the company's Junction shaft, in the Bisbee district, Arizona, broke on Dec. 7, interrupting pumping service for several hours. An operator, trying to repair the damage in the dark, was injured by the live current. Proper bulkheading prevented the hazard of flooding the lower levels.

Consolidated Mining & Smelting. The directors of the company have decided to curtail exploration and development of non-productive properties because of the current depressed metal market. At the end of November, the company had one month's production of lead and less than two months' production of zinc unsold. Mines and plants are in excellent condition—production has increased and costs have been reduced. The first section of the new fertilizer plant, which will produce sulphuric acid, triple superphosphate, and mono-ammonium phosphate, will begin production before the end of 1930. The ammonia plant will be completed next September, when the entire unit, producing 400 tons of fertilizer daily, will be put in operation.

Federal Copper. Construction of a 200-ton smelter is proceeding at the company's properties in the Altar district, Sonora, Mexico. It will treat oxide, carbonate, chalcopyrite, and chalcocite ores, according to William Kemp, of Tuscon, president and general manager of the company. Production is expected to start early in 1931. The vein formation is monazite granite with porphyry intrusions. Development work has been done through three shafts, of which the main shaft has been timbered and is now being equipped with a hoist and compressor plant. Mr. Kemp expects the average grade of ore smelted to be about 10 per cent copper, with some gold and silver.

Golconda Lead. Production of concentrate from the plant in the Coeur d'Alene district, Idaho, is about five carloads of lead and five carloads of zinc monthly, as operations are still on a one-shift basis. About 45 men are employed, largely on development work at the 1,400 and 1,800 levels. A crosscut is being extended at the latter depth to cut the orebody.

Granada Rouyn. In crosscutting at the property, in the Rouyn district of Quebec, a new vein was cut on the 625 level between the shaft and the No. 1 vein. Additional compressor capacity is being installed and development work will be expanded. Production is being maintained at a daily rate of from 65 to 75 tons of ore, averaging $15 per ton in gold.

M. A. Hanna Company. This organization has started extensive development work and diamond drilling on the copper properties it recently acquired from U. S. Copper, near Clifton and Metcalf, Ariz. George M. Harley is in charge of operations.

Lake George Metal. Although a bill sanctioning construction of the railroad from Bungendore to Captain's Flat, New South Wales, Australia, where the company's property is situated, has been passed by the New South Wales Parliament, construction has not yet started. Development work has virtually been completed, with 2,000,000 tons of ore, averaging 12.9 per cent zinc and 7.5 per cent lead, blocked out and an additional 880,000 tons indicated. Equipment of the property to handle 1,000 tons of ore daily has been deferred till metal prices improve.

Mexican Corporation. Ore reserves at the company's Teziutlan unit, Puebla, Mexico, were estimated at 128,120 tons, averaging 3.3 per cent copper, 12 per cent zinc, 2.3 oz. of silver, and 0.5 dwt. of gold per ton on June 30. This total represents virtually no change from the amount of ore in sight at the same time last year, despite extraction of 63,760 tons of ore during the year. Because of the increase in development work, in connection with the new Minerva orebody, average costs per ton of ore milled increased from $10.51 to $12.17. Production from this new orebody is expected to start in the first half of 1931.

Mines de Villemagne. Production at the property, in southern France, during November was about 50 per cent of capacity, only 6,752 tons of ore being milled. Concentrate production was 377 tons of lead and 543 tons of zinc. Comparable figures for October were 13,091 tons of ore, 535 tons of lead concentrate, and 791 tons of zinc concentrate.

New Guinea Goldfields. Drifting at locations Nos. 3 and 8, in the plateau section of the property near Wau, New Guinea, has been in ore of better than average grade recently. The last 54 ft. for which results are available at location No. 3 indicate an average grade of about 275s. in gold per ton over an average width of 46 in. Drifting has been in ore at this location for a total of 752 ft. The last 120 ft. at location No. 8, where ore has been followed for a total of 916 ft., shows an average grade of 135s. per ton over an average width of 4 ft. According to figures given at the last meeting of Mining Trust, which controls New Guinea Goldfields, the average assay of all work done on the plateau has been 72s. per ton over a width of 44.5 in.

Park Bingham Mining. A new 550-cu.ft. Ingersoll-Rand compressor, an electric hoist, General Electric motors, and other equipment have been installed at the surface plant at Bingham, Utah. They replace equipment destroyed in a fire early in December. Production by Bonanza Mining, which operates a lease on Park Bingham ground, will be resumed.

Reno Gold Mines. Production at the property, in the Sheep Creek district, of British Columbia, is being maintained at between $14,000 and $18,000 in gold monthly. Shipments were started in the summer of 1929. Because of the heavy snowfall in the district, suspension of operations for a short time during the dangerous period of snowslides may be necessary.

Seneca Copper. The property, near Ahmeek, Mich., has been completely shut down because of the low price of copper. Seneca was reopened in 1928, when copper prices were rising. Considerable development work was done and, although the property was never put on full-scale production basis, at one time it was shipping well over 1,000 tons of ore daily to the Lake No. 2 mill, at Hubbell. Pumps will be kept working during the shutdown.

Tintic Standard. Because of the unemployment situation, the company has added 50 men to its development force. They will be put to work at both the Tintic Standard lead mine and the Eureka Standard gold mine, in the Tintic district of Utah.

Tom Reed. Crosscutting on the 1,100 level of the mine, at Oatman, Ariz., has struck the Aztec vein. Drifting along the vein is now under way. In the meanwhile, production is coming largely from the Gray Eagle orebody between the 1,100 and 950 levels. About 100 tons of ore from the mine is handled daily in the cyanide plant. Shipments to the mill from the Siders lease have been temporarily suspended, pending the driving of a new crosscut to the orebody.

Utah-Apex Mining. Development work is being continued at the property, near Bingham, Utah, but production has ceased because of low prices of nonferrous metals. Shipments of ore and concentrate amounted to 84 carloads during the two weeks ended Dec. 5, preparatory to closing. Within recent years Utah-Apex production has been steadily declining, owing to decreasing reserves.

Walker Mining. A five-day week has been adopted at the property in Plumas County, Calif., so as to curtail copper production from 1,500,000 to 1,000,000 lb. monthly without necessitating the discharge of any men. Walker has been handling 1,600 tons of ore daily in its enlarged mill, and since the suspension at Engels Copper it is one of the two large copper producers still operating in the state, the other being Mountain Copper.

Patiño Mines Ajusting Working Hours

La Paz, Bolivia, Dec. 6.—Further readjustment is being made at the properties of Patiño Mines & Enterprises, largest tin producer in Bolivia. The slump in the price of tin has completely wiped out the company's profits and caused a very substantial reduction in tin production. To avoid dismissing a large part of its force, the company put the workers on a part-time basis. However, the move has evidently not met with the favor of the Bolivian government, or of the workers, who expressed their disapproval violently earlier in the year. The company is now reported to be releasing 2,000 men and retaining 3,000 on full-time employment to aid the Bolivian economic situation. As the Bolivian summer is just now beginning, it is hoped that undue suffering will not result.

. . . . Reports that the Huanuni tin dredge, operated by Americans, had been shut down are incorrect. The plant is continuing operations with good results. It produces about 200 tons of tin concentrate monthly.

EXCLUSIVE

CABLES

FROM CORRESPONDENTS IN THE PRINCIPAL MINING CENTERS

Shareholders Approve Merger of Rhodesian Properties

London, Dec. 18. — Sir Auckland Geddes at the meeting of Rhodesian Congo Border Concession shareholders, held yesterday to confirm the deal whereby that company will absorb Bwana M'Kubwa Copper and N'Changa Copper, stated that R.C.B.C. will, by the proposed transaction, secure the financial backing of the Rothschild and Morgan interests, probably the leading firms in the field of international finance. The merged company, the interests of which will be in Northern Rhodesian copper mines, will be under British control, as about two-thirds of the stock will be in British hands, with most of the remainder held by Americans. The terms of the merger include the increase of the R.C.B.C. capital from £750,000 in £1 shares to £2,000,000, all in £1 shares. Bwana M'Kubwa stock will be absorbed on the basis of one R.C.B.C. share for every 23½ Bwana shares. N'Changa stock will be exchanged on the basis of four for one R.C.B.C. In addition, an issue of £6,000,000 of 7 per cent debentures will be made, of which £4,500,000 will be offered to stockholders on a pro-rata basis. These debentures will carry the right of conversion into common shares.

. . . . Sir Henry Strakosch, of Union Corporation, and R. E. McConnell, American mining engineer and financier, were the only R.C.B.C. directors to oppose the merger, which was ratified at the meeting. At the meeting of Bwana M'Kubwa shareholders, only one voice was raised in opposition. N'Changa has not yet held a meeting to approve the proposition.

. . . . The merged company will control the N'Kana mine of Bwana M'Kubwa, with 100,000,000 tons of ore, averaging 3.9 per cent copper, proved, and a 5,000-ton mill under construction; the N'Changa mine, which has reserves of more than 70,000,000 tons of ore, averaging about 4 per cent copper; the N'Changa West Extension property of R.C.B.C., generally estimated to have proved about 50,000,000 tons of 8 per cent copper ore; concession rights over more than 45,000 square miles of ground in Northern Rhodesia, and the Bwana mine, with reserves of at least 7,000,000 tons of ore, averaging 3.5 per cent copper, and a 1,000-ton leaching plant in operation. At the R.C.B.C. meeting, the estimate was made that production of the merged properties will reach 390,000,000 lb. of copper annually within five to six years.

. . . . A railroad has already been constructed to the N'Kana mine from N'Dola, the center of the copper district, and it is being continued on to the N'Changa property. N'Kana will be the first of the three big properties to enter production, as the metallurgical treatment of the complex oxide-sulphide ores found in the R.C.B.C. and N'Changa deposits has not been fully worked out yet. Through the merger, the two last-named properties, which adjoin each other, can be worked as one mine.

. . . . Many crosscuts at the N'Kana mine fully confirm the grade and width of ore indicated by near-by drill holes, according to a statement made at the meeting. Fears had been expressed in some quarters that the drill results did not give an accurate picture of the deposits. Most of the knowledge of all the Rhodesian deposits, of course, has been gained through drilling, as only N'Kana and Roan Antelope, among the big mines, have yet made much progress underground. The N'Changa West Extension deposit of R.C.B.C., which is of much higher grade than any of the ore-bodies, is regarded as of enormous value by the company's engineers, according to facts brought out at the meeting. Drill hole NE 44, the latest hole put down, is reported to have averaged 9.27 per cent copper over the last 50 ft. This hole cut ore at a depth of about 1,200 ft.

. . . . Consummation of the merger brings all the important Northern Rhodesian deposits, with one exception, under the control of two groups—the other group being Rhodesian Selection Trust and the exception being Rhodesia Katanga. Rhodesian Selection Trust controls the Mufulira, Roan Antelope, and Chambishi deposits, with aggregate reserves almost as large in tonnage as those of the R.C.B.C. group but of lower grade. This company expects to be producing about 200,000,000 lb. of copper annually by 1934, indicating a total output of not less than 600,000,000 lb. from Northern Rhodesia by 1935 or 1936. Rhodesia Katanga is developing the Kansanshi mine. It is affiliated with Tanganyika Concessions.

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Rand December Dividends Will Show Gain

Johannesburg, Dec. 14.—Payment of the semi-annual dividends by Transvaal gold producers this month includes three companies that have increased or resumed payments, and, as the others have maintained their rates, the year's total disbursements will show a gain. Sub Nigel, the highest-grade mine in the province, has increased its disbursement from 2s. to 3s. per share on the 1,500,000 shares of 10s. par outstanding, or from £150,000 to £225,000. Lower costs are responsible for the larger payment, which is the same as that made in December, 1928. Robinson Deep, benefiting from its merger with Village Deep, has been enabled to pay a dividend on its B shares, which have not received one since 1926, and Simmer & Jack, which has not paid a dividend on its 5,000,000 shares of 2s. 6d. par since 1927, also resumed payments. Slight improvement in grade is responsible for this declaration. In a period when most industrial and mining concerns are forced to eliminate or reduce dividend payments, the strength of the Witwatersrand industry is certainly a cheering factor and is contributing greatly to the alleviation of the effects of depression throughout the Union of South Africa.

. . . . Durban Roodepoort Deep, one of the smaller producers on the West Rand, is showing marked improvement. The tonnage handled has slowly increased from the average of 40,000 tons of ore monthly, maintained for many years, to about 46,000 tons monthly. Grade is about 6.9 dwt. per ton. Additional new equipment is going into commission early in 1931, which should considerably increase profits. In 1929, the company made an operating profit of £46,120. At present, about £6,500 monthly is being cleared, and dividends, which were resumed in the spring at a rate of 2½ per cent on the capitalization of £375,000, may be increased.

. . . . Reports, said to emanate from authoritative sources, state that the Union of South Africa government has approved the various agreements among itself, the large diamond producers, and the diamond syndicate with regard to production and sales. The agreements now await only official signature to go into effect.

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Wiluna Gold Production to Start in March

London, Dec. 18. — Wiluna Gold, operating at Meekatharra, Western Australia, is expected to start production from its new plant, capacity 40,000 tons of ore monthly, in March. About 90 per cent of the plant has been constructed, and reserves of 1,500,000 tons of ore, averaging 39s. in gold per ton, have been proved. C. E. Prior, general manager, estimates recoveries at 29s. per ton and costs at 19s. Some engineers here regard the cost figure as too low and express doubt as to the profitableness of the enterprise.

. . . . New Goldfields of Venezuela, operating in the Bolivar district of Venezuela, has taken over the holdings of Bolivar Venezuela Gold Mines. Milling in the new 350-ton plant for the last three months has yielded 4,937 oz. of gold, indicating an average value of the ore of 19.18 dwt. per ton. Mine developments are reported encouraging.

. . . . Evidently there is trouble brewing for Chosen Corporation, gold-silver producer operating in Korea. A circular issued by L. Rondon, C. H. Bourke-Brrowes, and M. Casenave, three of the company's directors, suggests that M. C. Harman and B. F. Conigrave, also directors, should not remain on the company's board and also on the board of directors of one of the banks with which the company deals. The bank is said to owe the company £35,000. Mr. Harman is chairman of the Chosen board.

. . . . San Francisco Mines of Mexico, lead-zinc producer operating in Chihuahua, Mexico, has declared a 10 per cent dividend for the fiscal year ended Sept. 30. Last year it paid 37.5 per cent.

MARKET AND FINANCIAL NEWS

Total Stocks of Copper Down in November

The November copper statistics, released on Dec. 12 by the American Bureau of Metal Statistics, revealed a decline in stocks of blister in the hands of North and South American producers of 15,614 tons and an increase in the stocks of refined of 4,902 tons, or a net reduction in total stocks of 10,712 tons. This is the first reduction in total stocks reported since last July. The full effect of the curtailment program is not expected to make much of an impression before the end of January, but the figures for November indicated clearly that the reduced rate of operations was put into practice as soon as the necessary readjustments could be made. Total stocks of blister and refined copper at the end of November stood at 594,363 tons, against 605,075 tons a month previous.

United States mine production was reduced to the extent of 2,813 tons, the daily rate for November being 1,771 tons, against 1,805 tons in October, and 2,531 tons in November, 1929.

Summary of Copper Statistics

In Tons of 2,000 Pounds

Production:	October	November
Mines, United States	55,954	53,141
Blister, North America (a)	84,395	76,449
Blister, South America (a)	27,836	22,580
Refined, No. & So. America	118,229	112,646
World, blister basis	152,544	(c)
Stocks (end of month):		
No. & So. America:		
Blister (b)	240,145	224,531
Refined	364,930	369,832
Totals	605,075	594,363
Great Britain (d)		
Refined	5,042	6,311
Other forms	3,217	2,628
Totals	8,259	8,939
Havre	6,572	5,206

(a) Includes direct-cathode copper. (b) Includes in process. (c) Not yet available. (d) Official warehouses only.

U. S. Mine Production

	October	November
Porphyry mines	20,816	19,887
Lake mines	5,695	6,209
Vein mines	25,329	23,945
Custom ores	4,114	(a) 3,100
Total crude production	55,954	53,141
Daily rate	1,805	1,771

(a) Partly estimated.

Smelter Production

	October	November
United States	70,419	64,816
Canada	8,573	7,678
Mexico	5,403	3,955
Totals	84,395	76,449

Shipments

North and South America

	Export	Domestic	Total
September	37,873	65,169	103,042
October	38,246	75,703	113,949
November	45,051	62,693	107,744

U. S. Zinc Output Curtailed

Production of zinc in the United States during November amounted to 31,976 tons, a decline of almost 22 per cent from the October total. In spite of the substantial reduction in output, stocks at the end of the month increased again, though the gain amounted to only 1,606 tons. The disappointing November shipments, the total for the month being 30,370 tons, against 32,655 tons in October, was largely responsible for the increase in stocks.

Domestic zinc statistics for October and November, as compiled by the American Zinc Institute, in tons, are summarized as follows:

	Oct.	Nov.
Production	40,940	31,976
Production, daily rate	1,321	1,066
Shipments, total	32,655	30,370
Shipments, export	0	0
Stocks at end of month	141,232	142,838
Unfilled orders	29,510	24,481
Retorts operating at end of month (a)	41,004	37,492

(a) Retort capacity relates to Prime Western and a small quantity of Brass Special and High-Grade production.

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Alaska Juneau Declares First Dividend

Alaska Juneau Gold, largest Alaskan gold producer and probably the lowest-grade lode mine in the world, has declared its first quarterly dividend of 10c. a share, payable Feb. 1, 1931. The dividend will be paid on 1,446,000 shares of stock outstanding, indicating an annual disbursement of about $600,000. Alaska Juneau has been producing on a large scale since 1915, its property being credited with a total gold output of $21,608,972 to the end of 1929. In that period about 32,000,000 tons of ore was handled.

Because of the low grade of the ore handled, the chief problem of the management has been the reduction of costs of mining and milling to a point where profitable operation is possible. Continued experiment and frequent rebuilding of plant were necessary to achieve the success which the company has after a period of years at last apparently attained.

Alaska Juneau in November mined and trammed to mill 322,150 tons, from which estimated receipts totaled $296,500, or 92.04c. per ton; operating expenditures totaled $173,500, or 53.86c. per ton; and operating profit was $123,000, or 38.18c. per ton. Other expenditures and accrued charges were $2,500, leaving a surplus of $120,500 for the month. Indebtedness to the amount of $150,816.07 was paid, leaving Alaska Juneau with a clean slate after having paid off a total of $3,378,586.57 indebtedness.

Estimates place net income for 1930 at about $1,057,800. Payment of bond indebtedness during the year totaled $893,400, and the probable balance available for depreciation and federal income taxes is $164,400. During the eleven months a total of 3,598,380 tons was mined and trammed to mill, from which estimated receipts were $3,076,800; estimated costs, $1,853,500, and estimated surplus was $973,850.

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Silver Production Up in U. S. and Canada

Production of silver in the United States during November amounted to 3,852,000 oz., against 3,816,000 oz. in October, and 5,795,000 oz. in November, 1929, according to the American Bureau of Metal Statistics. The moderate increase in production which took place in November is attributed to the natural tendency to work high-grade ore when prices for metals are low.

Canadian production of silver during November totaled 2,445,000 oz., against 2,291,000 oz. in October, and 1,833,000 oz. in November last year.

Output in Peru registered a severe drop, owing to the temporary suspension of operations at Cerro de Pasco. Production in Peru for November amounted to 677,000 oz., against 1,480,000 oz. in October, and 1,604,000 oz. in November, 1929.

Australia produced 736,000 oz. of silver during November, against 709,000 oz. in October.

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Mexican Corporation Profit

Mexican Corporation, holding company with interests in the Fresnillo and Teziutlan mines, in Mexico, reports dividends from its subsidiary companies of £68,446 during the year ended June 30. After office expenses and interest charges, the balance carried to the balance sheet amounted to £55,171. In the previous year, the company received no dividends from its subsidiaries. Profit at the Fresnillo mine was $1,080,446, compared with $1,592,904 in the preceding year, and at the Teziutlan mine, $34,777, compared with $177,509 in the preceding year.

Low 1930 Zinc Prices Have Checked Developments

S. D. Strauss
Assistant Editor

In *E.&M.J.* of Feb. 24 last a list of potential additional sources of zinc was published. Eighteen different mines were included and the aggregate of their expected addition to the world's zinc supply was given as 330,000 tons annually, a total which they were expected to reach within two or three years. By the end of 1930, their annual rate of production was expected to be 185,000 tons higher than in 1929. The names of these mines and their expected production, as then published, were:

Mine	Location	Tons of Zinc Annually
New in 1929		
Base Metals	Canada	10,350
Empire	Colorado	24,075
Star	Idaho	20,100
Tybo	Nevada	6,500
New in 1930		
Mount Isa (a)	Australia	5,000
Rosebery	Australia	29,700
Amulet	Canada	7,500
Flin Flon	Canada	25,000
Sherritt Gordon	Canada	11,000
Sterling	Canada	5,000
Trepca	Yugoslavia	14,000
Sylvia Lake	New York	14,400
Universal Ex	Tennessee	13,500
New later		
Lake George	Australia	16,200
Mount Isa (a)	Australia	35,000
Errington	Canada	23,000
Pend Oreille	Washington	34,000
United Verde	Arizona	36,000
Cerro de Pasco	Peru	36,000

(a) Only first unit in operation in 1930.

The zinc industry has passed through a most disastrous period since that article was written. The price of the metal has been at its lowest point since long before the World War. Funds have not been readily available for the development and equipment of additional zinc deposits. Project after project has been postponed or abandoned.

Of the properties listed in the foregoing, Base Metals, Amulet, Star, and Sterling are now completely shut down, after having started operations at the rate indicated. The Tybo mine is operating on a one-shift basis, during the continuation of development work. The Rosebery mill, now completed, will probably not be started until metal prices improve, and the pilot plant at Zeehan which formerly served the mines has been closed. Sherritt Gordon is reported to have abandoned the idea of recovering the zinc content of its ore while prices remain low. The officials state that the matter will be "considered" when copper production is started, probably in January, 1931. Mount Isa is just getting under way and Flin Flon is slowly increasing its tonnage of ore to mill capacity. So far as is known, Empire, Sylvia Lake, Universal, and Trepca are operating at capacity.

Of the projects for which no definite date of starting production had been set, Lake George has indefinitely postponed mill construction—although plans now contemplate a unit twice as large as originally scheduled—that is, one that will handle 1,100 tons of ore daily and produce about 33,000 tons of zinc annually. Errington has failed to find the extension of its orebody at the 1,500 level, as expected, and construction of its large-scale plants appears doubtful. The 300-ton pilot mill has been closed. Pend Oreille, also, apparently has been forced to delay its ambitious plans for large production, and is now handling 200 tons of ore daily in a pilot plant. United Verde will not attempt to build an electrolytic zinc plant until conditions improve. Mount Isa will bring its additional units into operation when metal markets justify. Low metal prices and labor difficulties have somewhat retarded construction of Cerro de Pasco's new lead-zinc units.

Since publication of the compilation in February, two or three important additions to zinc-producing capacity at large mines have been announced. Of these, the most important is the doubling of concentrator capacity at Buchans, in Newfoundland, which will bring the company's potential zinc production up from about 25,000 to about 50,000 tons of metal annually. San Francisco Mines of Mexico is gradually raising mill tonnage from 800 to 1,400 tons of ore daily, or the annual equivalent of 22,500 additional tons of zinc. Huanchaca, in Bolivia, which started a 450-ton mill late in 1929, is reported to be producing 14,000 tons or so annually.

The following tabulation shows the rate at which the "new" mines are operating at present. The total of 97,975 tons compares with 185,000 tons scheduled.

Mine	Annual Rate, Short Tons, Present Production
Empire	(b) 24,076
Tybo	2,000
Mount Isa	5,000
Flin Flon	25,000
Trepca	14,000
Sylvia Lake	(b) 14,400
Universal Ex	(b) 13,500
	97,975

(b) Estimated; actual figures not available.

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Financial Notes

Bunker Hill & Sullivan, Coeur d'Alene lead-silver producer, has declared a regular monthly dividend of 25c. a share on its common stock, payable Jan. 6. The extra dividend of 25c., which has been paid monthly throughout 1930, has been discontinued for the present because of the large stocks of lead that the company has on hand.

Noranda Mines, Quebec copper producer, will not pay the regular quarterly dividend due at this time. The omission resulted from the low price of copper. Noranda was recently put on a $2 yearly basis, after initial payments payments at the rate of $3 annually.

Mother Lode Coalition, Alaskan copper producer, has passed its regular semi-annual dividend, due at this time, because of the low price of copper.

Domestic Lead Production Reduced in November

Stocks of refined lead in the United States at the end of November amounted to 90,402 short tons, a gain of 6,027 tons compared with the figures released a month previous. Production from domestic ore was reduced from 50,402 tons in October to 43,423 tons in November, but the decline in output was offset to a large extent by a reduction in shipments. Shipments reported by producers for the month of November totaled 43,062 tons, against 45,129 tons in October, and an average of 54,253 tons monthly for the first eleven months of the year.

Production statistics, stocks, and shipments, in tons, follow:

Production	Oct.	Nov.
From domestic ore	50,402	43,423
Secondary and foreign	4,967	5,565
Totals	55,369	48,988
Stock at beginning (a)	73,669	84,375
Total supply	129,038	133,363
Stock at end (a)	84,375	90,402
Shipments by difference	44,663	42,961
Shipments reported	45,129	43,062

(a) Domestic only.
The United States lead refinery statistics account for refineries at Omaha, Selby, Perth Amboy, Carteret, Collinsville, East Chicago, Herculaneum, Grasselli, Federal, Kellogg, Galena, Newark, Matawan, Indianapolis, Joplin, and Ontario.

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Santa Gertrudis Earnings

Despite the drop in the price of silver from an average of 56.7c. an ounce during the year ended June 30, 1929, to 46c. an ounce for the year ended June 30, 1930, Santa Gertrudis, large British-controlled silver producer in the Pachuca district, increased its profits by £18,229, to £328,783. After payment of dividends, provision for income tax, and addition of £50,000 to the reserve account, the company had a credit balance of £39,063, compared with £24,550 at the end of the 1929 fiscal year. Production in the last fiscal year was 8,958,126 oz. of silver and 36,875 oz. of gold, compared with 9,655,056 oz. of silver and 40,255 oz. of gold in the previous year.

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Prosperity Mining, subsidiary of Premier Mining, operating a silver-gold mine in the Portland Canal district, British Columbia, reports a net profit of $192,155 in the year ended Oct. 31. Production was 1,349,801 oz. of silver and 360 oz. of gold from 17,231 tons of ore. Gross smelter value was $29.53 a ton.

Federal Mining & Smelting, operating lead-zinc mines in Idaho and the Tri-State district, reports net earnings, before depreciation, depletion, and taxes, of $266,672 in the third quarter of 1930, compared with $273,650 in the preceding quarter and $785,780 in the corresponding period of the preceding year. Production was 32,688 tons of lead and zinc concentrates.

Prices of Copper, Zinc, Tin, and Silver Decline in Dull Market—Lead Steady

New York, Dec. 18, 1930.—Factors somewhat removed from the metal industry had a pronounced influence on traders, and operations were held down to a minimum. The failure of a large bank in New York temporarily confounded business in the financial district, and a fresh wave of pessimism brought out unexpected selling pressure in the commodity markets; metal prices were no exception. The November statistics, mostly favorable, were almost lost sight of because of the developments in Wall Street. Large producers of copper virtually withdrew from the market. Quite a few sellers of zinc also refrained from selling at the extreme lows for the movement, acting on the assumption that business will show some improvement after the turn of the year. Lead was the only major metal to show any stability.

Copper at 10c.

In the last two weeks the copper market was in the hands of custom smelters. Demand was dull and the price eased off almost daily, settling at 10c. per pound, Connecticut basis. Large producers withdrew from the market, being in a favorable position as regards sales because of the large volume of business booked about a month ago. The copper statistics for November showed a decline in total stocks of 10,712 tons, the first reduction since July. The full weight of the curtailment program may not be felt much before the end of January. Export demand also was dull. Copper Exporters, Inc., reduced the export price from 12.30c. to 11.30c. on Dec. 10. Another reduction was made on Dec. 16, establishing the export quotation at 10.80c.; a third decline was made Dec. 18, bringing the price down to 10.30c., c.i.f. European ports. Just before the close sentiment improved, and it was felt that both domestic and export prices would not drop below the final quotations for the period.

World production of copper during November totaled 139,914 tons, against 152,544 tons in October, and 152,405 tons in September. The daily rate for November was 4,664 tons, against 4,921 tons in the preceding month.

Lead Dull But Unchanged

Lead passed through an exceedingly quiet period, but the price held at 5.10c., New York, and 4.95c., St. Louis. Despite continued unsettlement in London and the apparent determination of domestic consumers to restrict purchases to the minimum, producers felt that little or nothing would be gained by reducing prices.

Zinc Down to 4c.

To attract business sellers were compelled to reduce prices, and toward the close sales went through as low as 4c., St. Louis, for Prime Western. A fair tonnage of zinc was sold at the lower levels. Some producers were out of the market. Curtailment of output is expected to aid the situation.

New Low for Tin

Straits tin sold down to 23.50c., New York, a new low for the year. Weakness in other metals, and discouragement over the slow movement of tin into consumptive channels, brought out renewed selling pressure. Output is in excess of current requiremnts.

Silver Weak

Silver suffered a further decline, touching a new all-time low on Dec. 16, the price on that day falling to 31⅝c., New York. Selling by China and slim hope for international action tending toward stabilizing prices accounted for the weakness.

Other Metals

Quotations cover wholesale lots, f.o.b. New York, unless otherwise specified. London prices are according to latest mail advices.

ALUMINUM—Per lb., delivered, Alcoa commercial and mill ingot, 99 and 98 per cent, 23.30c.; Alcoa No. 12 alloy, 22c.; metallurgical ingot, 94 per cent plus, 23.30c.; 98@99 per cent, 22.90c. London, £85, less 2 per cent, per long ton, for 98 per cent ingots and bars.

ANTIMONY—Per lb., duty paid, Chinese, spot, 7.10c.; futures, 6.875c. Cookson's "C" grade, spot, 12⅝c. "C.M.C." grade, 99.9 per cent, spot, 10¾c. London, Chinese, spot, £23 5s. per long ton.

BISMUTH—Per lb., in ton lots, $1.25. London, 5s.

CADMIUM—Per lb., 70c. London. 1s. 10d. to 1s. 11d.

CHROMIUM—Per lb., 97@98 per cent grade, 85@90c. per lb. contained chromium, maximum 1 or 2 per cent iron.

COBALT—Per lb., delivered: Metal imported from Belgium in the form of rondelles, 97@99 per cent, spot, $2.50. Discounts on contracts. London, spot, 10s. Nominal.

INDIUM—Per gram, minimum 99 per cent, $14@$15.

IRIDIUM—Per oz., $180@$200 for 98 @99 per cent sponge and powder. London, £37@£39.

MAGNESIUM—Per lb., ingots (4x16 in.), 99½ per cent, 48c., in 100-lb. lots or more; 2½- or 3-lb. sticks (1⅜x27 in.), 53c., 100-lb. lots or more. London, 2s. 9d.@3s. for 99 per cent ingots or sticks.

MANGANESE—Per lb., 95@97 per cent, 42c.

MOLYBDENUM—Per lb., in 10- to 50-lb. lots, C.P. powder, $9.50; 97 per cent, $6.50. (Usually sold as calcium molybdate or ferromolybdenum, which see.)

NICKEL—Per lb., ingot 35c.; shot, 36c.; electrolytic, 35c. (99.9 per cent), for single lots of spot metal. London, per long ton, £170@£175, as to quantity.

OSMIUM—Per oz., $65@$70. Nominal. London, £16@£17.

PALLADIUM—Per oz., $20@$22. London, £3 10s.@£4.

PLATINUM—Per oz.; Official price of leading interest, $36. Market quiet but steady. Cash transactions between dealers and refiners at several dollars less. London quotes £6 10s. to £7. Average price of Colombian crude, basis 85 per cent platinum, for the month of November was $26 per oz.

Complete Market News and Prices

THE semi-monthly magazine you are now reading carries only a condensed review of important market news and price movements. For buyers and sellers of ores, metals, minerals, and scrap who require reliable information as soon as it is available, we now provide *Metal and Mineral Markets*, which goes to press at the close of the metal-market week each Wednesday. It is printed at high speed and is in the mails that evening. In compact form, ready for insertion in a ring binder, it is ideal for desk and reference use. It carries the standard *E.&M.J.* quotations used in contracts the world over, recognized as authoritative and dependable. *Metal and Mineral Markets* is priced to subscribers in the United States and its possessions at $2 per annum; to countries in the Americas but outside the United States, $5; elsewhere, $10 yearly: 52 issues. Address *M.& M.M.*, 36th St. and 10th Ave., N.Y.City.

Daily Prices of Metals

Dec.	Electrolytic Copper	Straits Tin	Lead		Zinc
	Refinery	New York	New York	St. Louis	St. Louis
4	11.025@11.275	25.45	5.10	4.95	4.10@4.20
5	10.775@11.025	25.40	5.10	4.95	4.15
6	10.775@11.025	25.40	5.10	4.95	4.15
8	10.525@10.775	25.125	5.10	4.95	4.15@4.20
9	10.525	25.00	5.10	4.95	4.15
10	10.525@10.775	25.10	5.10	4.95	4.15@4.20
Av'ge	10.796	25.246	5.100	4.950	4.158
11	10.025@10.525	24.20	5.10	4.95	4.15
12	10.025@10.275	24.30	5.10	4.95	4.125
13	10.025	24.35	5.10	4.95	4.125
15	9.775	23.65	5.10	4.95	4.05
16	9.775	23.75	5.10	4.95	4.00
17	9.775	23.50@23.875	5.10	4.95	4.00
Av'ge	9.963	23.990	5.100	4.950	4.075

Average metal prices for calendar week ended December 6, 1930, are: Copper, 11.004c.; Straits tin, 25.638c.; New York lead, 5.100c.; St. Louis lead, 4.950c.; Zinc, 4.110c.; Silver, 34.396c.

Average metal prices for calendar week ended December 13, 1930, are: Copper, 10.379c.; Straits tin, 24.679c.; New York lead, 5.100c.; St. Louis lead, 4.950c.; Zinc, 4.150c.; Silver, 33.146c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices are quoted on a delivered basis; that is, delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices of refineries on the Atlantic seaboard. Delivered prices in New England average 0.225c. per pound above those quoted.

Quotations for copper are for the ordinary forms or wirebars and ingot bars. For ingots an extra 0.05c. per pound is charged; for slabs, 0.075c.; and for cakes, 0.125c. up, depending on weight. Cathodes are sold at a discount of 0.125c. per pound.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight differential. The contract price for High-Grade zinc delivered in the East and Middle West is 1c. above the St. Louis price for Prime Western.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

Silver, Gold, and Sterling Exchange

Dec.	Sterling Exchange "Checks"	Silver		Gold, London	Nov. Dec.	Sterling Exchange "Checks"	Silver		Gold, London
		New York	London				New York	London	
4	4.85 5/16	34 1/8	16	85s1 3/4d	11	4.85 1/2	33 5/8	15 9/16	85s1 1/2d
5	4.85 3/8	34 1/8	15 7/8	85s1 3/4d	12	4.85 7/16	32 1/4	15 1/16	85s1 1/2d
6	4.85 3/8	33 3/4	15 5/8	.....	13	4.85 7/16	32 1/2	15 3/16	.....
8	4.85 1/2	34	15 11/16	85s1 1/2d	15	4.85 7/16	32 7/8	15 1/4	85s1 1/2d
9	4.85 3/8	33	15 1/2	85s1 1/2d	16	4.85 5/16	31 5/8	14 1/2	85s1 1/2d
10	4.85 9/16	33 1/2	15 7/16	85s1 1/2d	17	4.85 7/16	31 7/8	14 11/16	85s1 1/2d

Average for week ended December 10: Silver, 33.750c.; Sterling Exchange, $4.85417.
Average for week ended December 17: Silver, 32.458c.; Sterling Exchange, $4.85427.

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of silver, 999 fine. London silver quotations are in pence per troy ounce of bar silver, basis of 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command five-thirty-seconds cent premium.

London

Dec.	Copper Standard		Electrolytic (Bid)	Tin		Lead		Zinc	
	Spot	3 M		Spot	3 M	Spot	3M	Spot	3 M
4	48 7/8	48 13/16	53	112 3/4	114 1/8	15 7/8	16	14	14 9/16
5	48	48	52 1/2	113	114 1/4	15 13/16	15 7/8	13 3/4	14 5/16
8	47 5/16	47 5/16	51	112 1/4	113 1/2	15 5/16	15 5/8	13 3/4	14 1/4
9	46 3/4	46 3/4	51	111 5/8	112 7/8	15 7/16	15 1/2	13 13/16	14 5/16
10	46 5/8	46 3/4	50	111 5/8	113	15 3/8	15 7/16	13 13/16	14 1/4
11	46 1/16	46 1/16	50	108 7/8	110	15 7/16	15 1/2	13 3/4	14 1/4
12	45 3/8	45 1/2	49	108 1/4	109 1/2	15 1/8	15 1/8	13 5/8	14 1/8
15	45 3/8	45	48	106 5/8	107 3/4	15 1/8	15 1/8	13 1/2	14
16	44 1/2	44 1/16	47	105 1/2	106 3/4	14 7/8	14 7/8	13 5/16	13 13/16
17	43 5/8	43 1/2	46	104 1/2	105 5/8	14 5/8	14 5/8	13 1/4	13 3/4

Prices for lead and zinc are the official prices for the morning session of the London Metal Exchange; prices for copper and tin are the official closing buyers' prices. All are in pounds sterling per long ton (2,240 lb.).

QUICKSILVER—Per 76-lb. flask, $104 @$106. Prices were unsettled on fairly liberal offerings. Demand was quiet. London, £22 10s.

RADIUM—Per mg. radium content, $50 in lots of 4 grams or more, to $65 for 1 gram; smaller quantities, $70.

RHODIUM—Per oz., $55. Nominal.

RUTHENIUM — Per oz., $46@$48. Nominal. London, £9½@£10.

SELENIUM—Per lb., $1.80@$2, depending on quantity, for black, powdered, 99.5 per cent pure. London, 7s. 8d.

SILICON—Per lb., minimum 97 per cent Si, maximum 1 per cent Fe, 15@17c.

TANTALUM—Per kilo, $128 for C.P. sheet.

TELLURIUM—Per lb., $2.

THALLIUM—Per lb., $12.50@$15.

TITANIUM—Per lb. in 50- to 100-lb. lots, 75 per cent, $5.

TUNGSTEN—Per lb. contained tungsten, 98 per cent, powdered, $1.55.

Metallic Ores

Prices in tons of 2,000 lb., or in "units" of 20 lb., unless otherwise stated.

ANTIMONY ORE—No sales reported. London, per long ton unit, 3s. 9d.@4s. for 60 per cent sulphide ore.

BERYLLIUM ORE—Per unit of BeO, minimum 11 per cent BeO, $4@$5, f.o.b. mines. Per lb. BeO contained, 40c., c.i.f. European ports.

CHROME ORE—Per long ton, c.i.f. Atlantic ports, Indian ores, $19.50 for 46@48 per cent Cr_2O_3 ore, and $24 for 50@51 per cent ore. London, 77s. 6d. for 48 per cent Rhodesian, and 80s.@95s. for Indian and New Caledonian, according to quality.

IRON ORE—Per long ton, Lower Lake ports. Lake Superior ores:

Mesabi, non-bessemer, 51½ per cent iron, $4.50. Old Range, non-bessemer, $4.65.

Mesabi, bessemer, 51½ per cent iron, $4.65. Old Range, bessemer, 51½ per cent, $4.80.

Colorado, per long ton unit, f.o.b. mines, 20 to 23 per cent, 6½c.

Eastern ores, cents per unit, delivered at furnaces: Foundry and basic, 56 to 63 per cent, 10c.

Foreign ores, alongside docks Atlantic ports, cargo lots, cents per unit:

North African and Swedish, low-phosphorous, 10@10½c.

Spanish and North African basic, 50@60 per cent, 9@9½c.

Swedish foundry or basic, 65@68 per cent, 10c.

Newfoundland foundry, 55 per cent iron, 9c.

MANGANESE ORE—Per long ton unit of Mn, c.i.f. North Atlantic ports, cargo lots, exclusive of duty: Brazilian, 46@48 per cent Mn, 25c.; Chilean, 47 per cent minimum, 30½c.; Indian, 48@50 per cent, 27@28c.; Caucasian, 52 @55 per cent, 27@28c.; South African,

52@54 per cent, 27@28c., nominal. Inactive. Domestic, f.o.b. *Colorado* mines, 20 to 25 per cent, 30c.

Per ton in carload lots:

Chemical grades, powdered, coarse or fine, minimum 80 per cent MnO_2, Brazilian or Cuban, $60. Javan or Caucasian, 85 per cent minimum, $60. Domestic, 70 to 72 per cent, $60, f.o.b. mines.

MOLYBDENUM ORE—Per lb. of contained MoS_2, nominally 35@40c., delivered Pittsburgh. London, per long ton unit, nominal at 32s. 6d.@35s. for 80@85 per cent concentrate.

TANTALUM ORE—Per lb. Ta_2O_5, 75c. for 60 per cent ore. Per lb., f.o.b. *New Mexico* mines, crude ore with minimum 40 per cent Ta_2O_5, 85c.; 35 per cent, 65c.

TIN ORE — No market in United States. London, returning charge on 60 per cent Bolivian, £10 per long ton; on 70 per cent Nigerian, £6 17s. 6d.

TITANIUM ORE — Per gross ton, ilmenite, 45@52 per cent TiO_2, f.o.b. Atlantic seaboard, $10@$12, according to grade and impurities. Low-grade domestic, 32 to 35 per cent, about $7 @$8. Rutile, per lb., guaranteed minimum 94 per cent concentrate, 10c.

TUNGSTEN ORE—Per unit of WO_3, N. Y.: Chinese wolframite, $12, duty paid. Bolivian scheelite, $12, and domestic, $12.50. Market dull. Crude, low-grade ores, f.o.b. *Colorado,* $10 basis for 60 per cent WO_3.

VANADIUM ORE—Per lb. V_2O_5 contained, 26@28c., f.o.b. shipping point.

ZIRCON ORE — Per ton, 55 per cent ZrO_2, f.o.b. Atlantic seaboard, $40@$45 in 30-ton lots. Crude granular zircon, $70, f.o.b. Suspension Bridge, N. Y.; milled, $90.

Non-Metallic Minerals

Prices received for non-metallic minerals vary widely and depend upon the physical and chemical characteristics of the commodity. Hence the following quotations can serve only as a general guide to the prices obtained by producers and dealers in different parts of the United States for their own product. In the last analysis the value of a particular non-metallic mineral can be ascertained only by direct negotiation between buyer and seller.

Tons of 2,000 lb., unless otherwise noted.

AMBLYGONITE — Per ton, f.o.b. mines, 8@9 per cent lithium oxide, $50@$60.

ASBESTOS — Per ton, f.o.b. Quebec mines, tax and bags included: Crude No. 1, $350@$400; crude No. 2, $250@ $275; spinning fibers, $150@$175; magnesia and compressed sheet fibers, $100@$125; various grades shingle stock, $45@$65; various grades paper stock, $30@$35; cement stock, $15@ $20; floats, $10@$12.

Per ton c.i.f. New York: Rhodesian crude No. 1, $350; No. 2, $250. Nominal.

Per ton, c.i.f. New York: Russian crude, No. 1, $210; No. 2, $160; No. 3, $50.

BARIUM CARBONATE (Witherite) — Per ton, 90 per cent, 200 mesh, $47; 100 mesh, $44.

BARYTES—F.o.b. mines, bags extra:

Georgia: Barytes ore, crude, $6.50 per long ton.

Missouri: Per ton, water ground and floated, bleached, $23, car lots, f.o.b. works. Crude ore, minimum 93 per cent $BaSO_4$, less than 1 per cent iron, $7; 1 per cent iron and 93 per cent $BaSO_4$, $6.50, f.o.b. mines.

BAUXITE—Per long ton: Domestic ore, chemical, crushed and dried, 55 to 58 per cent Al_2O_3, 1.5 to 2.5 per cent Fe_2O_3, $6.50@$8.25, f.o.b. *Alabama* and *Arkansas* mines. Other grades, 56 to 59 per cent Al_2O_3, 5 to 8 per cent SiO_2, $6.50@$8, f.o.b. *Arkansas* mines. Pulverized and dried, 56 to 59 per cent Al_2O_3, 8 to 12 per cent SiO_2, $12@ $12.25, f.o.b. *Arkansas* mines; abrasive grade, crushed and calcined, 78 to 84 per cent Al_2O_3, $14@$16., f.o.b. *Arkansas* mines.

Per metric ton, foreign, c.i.f. Atlantic ports: Dalmatian, 50 to 55 per cent Al_2O_3, 1 to 3 per cent SiO_2, $4.50@ $6.50; one dealer reports $7 for material running 52@54 per cent alumina and 1.50 per cent silica; market fair. Istrian, 54 to 57 per cent Al_2O_3, 3 to 5 per cent SiO_2, $5.50@$7; French, 56 to 59 per cent Al_2O_3, 2 to 4 per cent SiO_2, $6@$8; 56 per cent Al_2O_3, 1.50 per cent SiO_2, $7; 58 per cent Al_2O_3, 3@4 per cent SiO_2, $6.50.

BENTONITE—Per ton, f.o.b. Wyoming mines, dried and crushed, in bulk, $8; in bags, $10. F.o.b. Chicago, selected air-floated, $25.

BORAX — Per ton, carload lots, in bags, crystals, $56; granulated, $50; powdered, $57.50; f.o.b. shipping point.

CELESTITE—Per ton in carload lots, 90 per cent $SrSO_4$, finely powdered, $27.

CHINA CLAY (KAOLIN)—Per ton, f.o.b. *South Carolina* mines, crude lump, No. 1, $4.50; crushed to ¼ in., $6; pulverized, $9.

Florida, washed and crushed, No. 1 $12.50; No. 2, $12.

Imported English, f.o.b. American ports; lump, $15@$25 in bulk.

EMERY—Per ton, f.o.b. *New York,* domestic crude ore, $10. Other American ore, delivered to grinders, per gross ton, $15; Turkish and Naxos ore, $30 @$35. F.o.b. *Pennsylvania,* in 350-lb. kegs, Turkish, Khasia, and Naxos grain emery, 6½c. per lb.; American, 3½c.

FELDSPAR — Per ton, f.o.b. *North Carolina,* 200 mesh, white, $18, in bulk; f.o.b. *Maine,* white, 200 mesh, $19, in bulk. Granular glasspar, f.o.b. *North Carolina,* $10.50, in bulk.

Virginia, No. 1, 325 mesh, $18; 200 mesh, $15@$16; 160 mesh, $14; No. 1 glassmakers', $11.

New Mexico: Crude clean No. 1 potash spar, $4.75; ground, $9.50.

FLUORSPAR — Per ton, f.o.b. Kentucky and *Illinois* mines:

Gravel, not less than 85 per cent CaF_2, and not over 5 per cent SiO_2, $17.25. Foundry lump, 85-5, $18. Ground, 95 to 98 per cent CaF_2, and not over 2½ per cent SiO_2, $32.50 in bulk; $36.50 in bags or barrels. *Colorado* mines, 82-5, $12.75.

FULLER'S EARTH — Per ton, f.o.b. *Colorado,* $18, various finenesses to minus 90 mesh.

F.o.b. *Georgia,* 30 to 60 mesh, $18; 15 to 30, $16.50; 200 up, $10; 100 up, $7.

GARNET—Per ton, f.o.b. *New Hampshire* mines: crude or mill run, $45; unwashed grades, $85; washed, $125.

New York: Adirondack garnet concentrates, $85.

Spanish grades, $60, c.i.f. port of entry.

GILSONITE — Per ton, carload lots, f.o.b. mines *Colorado:*

Selected grade, $33; seconds (mine run), $25.50.

GRAPHITE—Per lb., f.o.b. *New York:*

Ceylon lump, 7@8½c.; chip, 6@7c.; dust, 2@3c.; Madagascar flake, 6@8c.

No. 1 flake, 8@16c.; fine ground, 5c. upward; amorphous, 3c. upward.

Crude amorphous graphite, $15@$35 per ton, according to grade.

GREENSAND — Per ton, f.o.b. cars, *New Jersey:* Screened and bagged, best grade, in carload lots, $20. No. 2 grade, $15.

GYPSUM—Per ton, f.o.b. mill, crushed rock, *Iowa,* $2.50; *Ohio* and *New York,* $3. Ground, *Ohio,* $4; *Iowa,* $6. Agricultural, $6@$7. Calcined, $6@$9.

IRON OXIDE (See Ocher)—Per lb.: Standard Spanish red, 3@4½c.; domestic earth, 2@4½c.

KAOLIN—See China Clay.

LEPIDOLITE—Per ton, $50@$60 for ordinary grades. Nominal.

LIMESTONE—Per ton, f.o.b. shipping points, depending on location, either lump or crushed, 25c.@$1.75.

Agricultural, $1 up to $6 per ton.

MAGNESITE—Per ton, f.o.b. *California* steel mill points, dead-burned, $29. *Washington:* Dead-burned grain magnesite, $22.

MICA—Per ton, f.o.b. *New Mexico,* scrap, white, $21; off color, $18. Punch, white, for disks, per lb., 10c.; for washers, 8c.

Per ton, f.o.b. *New Hampshire,* roofing mica, $23; snow, $34; 40 mesh white, $40; 60 mesh, $48; 100 mesh, $60; 200 mesh, $75. Clean dry mixed bench and mine scrap, $13.

Per lb., f.o.b. *North Carolina*: Punch, 4@6c.; 1½x2 in., 25@35c.; 2x2, 45@60c.; 2x3, 85c.@$1; 3x3, $1.40 @$1.60; 3x4, $1.80@$2; 3x5, $2@ $2.25; 4x6, $2.75@$3; 6x8, $3.50@ $3.75; 8x10, $5@$7.50. These prices apply both to No. 1 and No. 2 mica. Black-stained mica takes a discount of 10 to 25 per cent from this schedule. White North Carolina mica, 70 mesh, $60 to $80. Biotite, or black mica, $15 a ton, unground.

MINERAL BLACK—(Graphitic shale) —Per ton, 325 mesh, 75 per cent carbon, $22.50, f.o.b. *Virginia.*

MONAZITE—Per ton, minimum 6 per cent ThO_2, $60.

OCHER — Per ton, f.o.b. *Georgia* mines, $17.50 in sacks; $20 barrels; second grade, $10. Buff clay, 98 per cent through 325 mesh, $18.

F.o.b. *Virginia,* dark yellow, 300 mesh, 60 per cent ferric oxide, in jute bags, $19.50.

PHOSPHATE—Per long ton, f.a.s. or f.o.b. mines:

Florida, pebble, f.a.s., for export: 76@77 per cent, $7.15; 75 per cent, $6.40; 74@75 per cent, $6.15; 70 per cent, $4.65; 68 per cent, $4.10.

Florida, pebble, domestic: 76@77 per cent, $6.50; 74@75 per cent, $5.50; 72 per cent, $4.50; 70 per cent, $4.

Tennessee, ground, 80 per cent through 300 mesh, 33 per cent P_2O_5, $11.80 per ton, bags extra.

POTASH—Per ton, contracts:

	Bags	Bulk
Muriate of potash, 80@85 per cent, basis 80 per cent	$37.15	$35.55
Sulphate of potash, 90@95 per cent, basis 90 per cent	48.25	46.65
Sulphate of potash-magnesia, 48@53 per cent, basis 48 per cent	27.80	26.20
Manure salt, 30 per cent	22.15	19.15
Manure salt, 20 per cent	15.65	12.65
Kainit, 14 per cent	12.70	9.70

Prices are delivered to Atlantic ports. Discounts up to 4 per cent for early shipment. Spot prices, $1.25@$1.50 per ton higher than on contract.

PUMICE STONE—Per lb., in barrels, powdered, 2½@4c.; selected lump, 5@7c.

PYRITES—Per long ton unit of sulphur, c.i.f. United States ports, guaranteed 48 per cent sulphur, Spanish, 13@13¾c.

[1]QUARTZ ROCK CRYSTALS—Per lb. in ton lots, colorless, clear but flawed, pieces ¼ to ½ lb. in weight, 20c. Flawless, for optical purposes, four times above price; larger crystals still higher.

SILICA—Per ton, water ground and floated, in bags, f.o.b. Illinois: 325 mesh, $16@$40 for 92 to 99½ per cent grades. Dry ground, air-floated, 325 mesh, 92@99½ per cent silica, $14@$30. Market steady. Glass sand, f.o.b. producing plant, $1.25@$5 per ton; molding sand, 50c.@$3.50; blast sand, $1.75@$6.

[1]SPODUMENE — Per ton, $50@$60 depending upon lithium content.

[1]STRONTIANITE — Per ton, lump in carload lots, minimum 88@91 per cent $SrCO_3$, $100.

SULPHUR—Per long ton for domestic market, $18 f.o.b. Texas mines; $22 for export, Atlantic ports.

TALC — Per ton, carload lots, f.o.b. works, containers included unless otherwise specified.

New Jersey: Soapstone, ground, $10@$12.

New York: Double air-floated, short fiber, 200 mesh, $13.75; 325 mesh, $14.75.

Vermont: 99 per cent through 200 mesh, extra white, bulk basis, $8@$8.50; 97 to 98 per cent through 200 mesh, medium white, $7.50@$8. Packing in paper bags, $1 per ton extra.

Virginia: 200 mesh, $6.25@$7.90; 325 mesh, $8.75@$11.

TRIPOLI — Per ton, burlap bags, paper liners, minimum carload 30 tons, f.o.b. *Missouri:* Once ground through 40 mesh, rose and cream colored, $15. Double ground through 110 mesh, rose and cream, $17. Air-floated through 200 mesh, rose and cream, $22.50.

Rolled Metals

COPPER — Per lb., sheets, hot-rolled, 20¾c.; wire, f.o.b. mill, 12¼c.

LEAD SHEETS—Per lb., full rolled, 8c.; clipped, 8¼c.

MONEL METAL—Per lb., sheets, full finished, 42c.; rods, hot-rolled, 35c.

MUNTZ METAL—Per lb., rods, 17⅛c.; plates, 19⅞c.

NICKEL—Per lb., sheets, full finished, 52c.; rods, hot-rolled, 45c.

NICKEL SILVER — Per lb., sheets, 10 per cent, 25¼@25¾c.; 18 per cent, 28½@29c. Wire and rods, 10 per cent, 28¾c.; 15 per cent, 32½c.; 18 per cent, 36c.

PHOSPHOR BRONZE—Per lb., sheets and rods, 5 per cent tin, 32c.; wire, 5 per cent, 32½c.; 10 per cent, 38c.

ZINC SHEETS — Per lb., 9½c., f.o.b. works; ribbon, 9c.; 7 per cent discount on orders for 18 tons or more.

Metallic Compounds

ARSENIOUS OXIDE (White arsenic)—Per lb., 4c., delivered, all positions. London, per long ton, £18 10s. for Cornish white.

CALCIUM MOLYBDATE OR MOLYTE—Per lb. of contained Mo, 95c.

COBALT OXIDE—Per lb., black, 70@71 per cent contained Co, $2.10. London, 8s. for black; 8s. 10d. for gray.

COPPER SULPHATE (Blue Vitriol)—Per lb., in car lots, 4.25c. for either large or small crystals.

GERMANIUM DIOXIDE—Per gram, in 200- to 300-gram lots, $3.50.

SODIUM NITRATE—Per 100 lb., crude natural, in bags ex vessel, Atlantic ports, $2.02.

SODIUM SULPHATE (Salt Cake)—Per ton, bulk, f.o.b. works, $15@$18.

ZINC OXIDE—Per lb. in bags, in car lots: Lead-free, 6½c.; 10, 20 or 35 per cent leaded grades, 6¼c.; French red seal, in bags, 9⅜c.

ZIRCONIUM DIOXIDE—Per lb. in 100- to 500-lb. lots, 87 per cent ZrO_2, commercial, 50c.

Refractories

CHROME BRICK—Per ton, f.o.b. shipping point, $45.

FIRECLAY BRICK — Per M., first quality, $43, *Ohio, Kentucky, Central Pennsylvania;* second quality, $35@$38.

MAGNESITE — Brick, per ton, f.o.b. works, 9-in. straights, $65. Dead-burned grain, $40, f.o.b. Chester, Pa., or Baltimore.

SILICA BRICK—Per M., *Pennsylvania,* $43; *Alabama,* $50@$51; *Illinois* and *Indiana,* $52.

ZIRKITE—Per lb., powdered, 65@70 per cent ZrO_2, 3½c. Brick, straights, 80c.@$1 each.

Alloys

FERROCHROME — Per lb. of contained chromium, 4 to 6 per cent carbon, 65 to 70 per cent chromium, 11c., delivered, on contracts; spot, 11½c. Containing 2 per cent carbon, 65 to 70 per cent chromium, 17½c.; maximum 0.10 per cent carbon, 26c.

FERROMANGANESE — Per gross ton furnace; domestic and foreign, 78@82 per cent, $80@$85, contracts, depending on quantity. Spiegeleisen, 19@21 per cent, $31 for spot carloads.

FERROMOLYBDENUM—Per lb. of Mo, f.o.b. shipping point, 50@60 per cent Mo, $1.

FERROPHOSPHORUS—Per ton, 18 per cent P, $91; electrolytic, 24 per cent, $122.50, f.o.b. *Alabama* and *Tennessee.*

FERROSILICON — Per gross ton, delivered, 50 per cent, $83.50; 75 per cent, $130; 14@16 per cent, $39, f.o.b. Niagara Falls, N. Y. Spot shipments $5@$10 per ton higher on 50 and 75 per cent grades.

FERROCARBONTITANIUM — Per ton, $150, f.o.b. producer's plant.

FERROTUNGSTEN—Per lb. of W contained, 75@80 per cent W, $1.10@$1.15, f.o.b. works.

FERROVANADIUM—Per lb. of V contained, delivered, $3.15@$3.50.

SILICOMANGANESE — Per long ton, carload contracts, delivered, $135 for maximum 2½ per cent carbon; $145 for maximum 1 per cent carbon.

SILICON ZIRCONIUM—Per lb., 47@52 per cent Si, 35@40 per cent Zr, 18@21c.

ZIRCONIUM FERROSILICON—Per gross ton, 12@15 per cent Zr, 39@43 per cent Si, $103.50@$108.50.

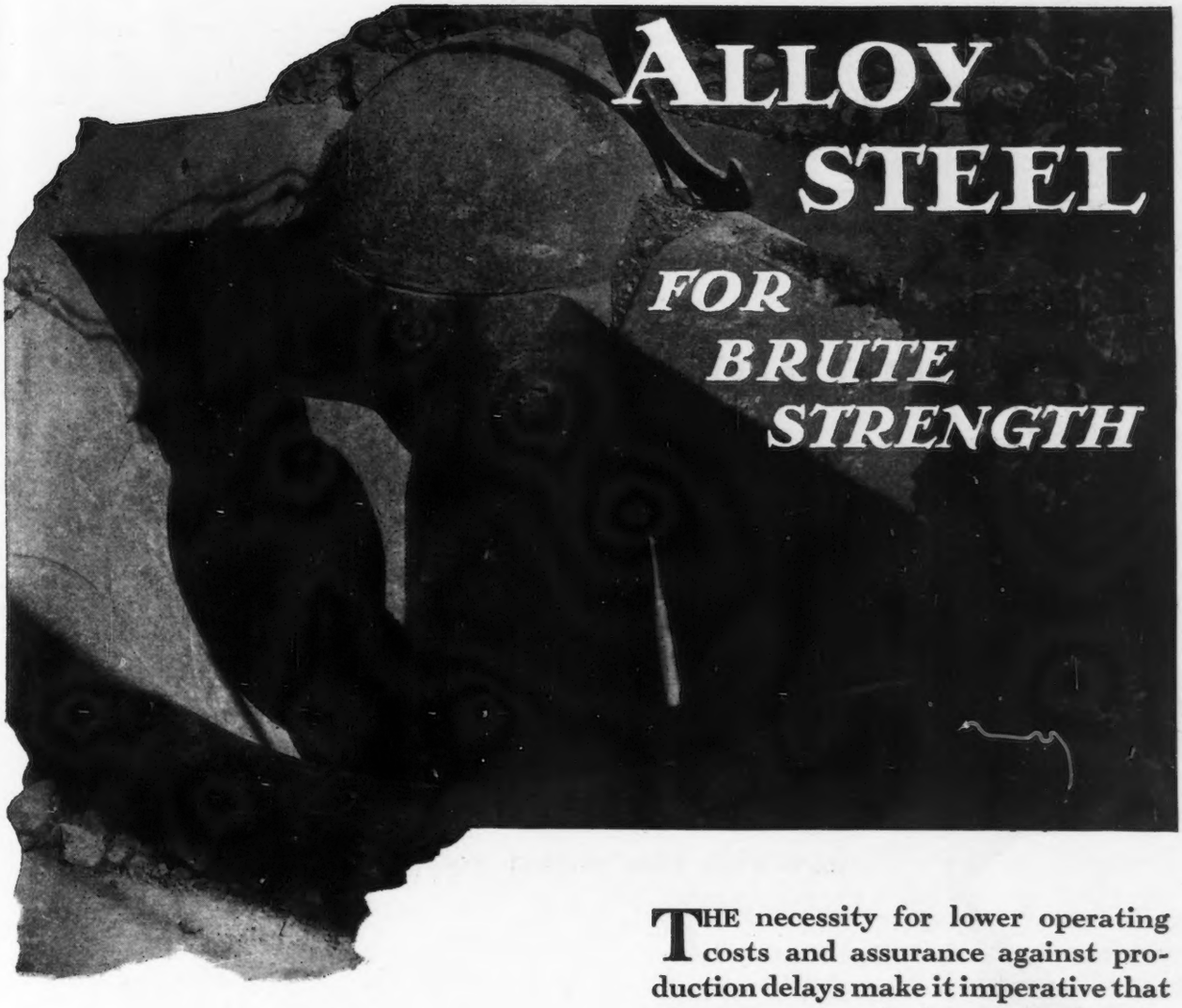
Iron, Steel and Coke

IRON—Per gross ton, Valley furnaces: Bessemer, $17.50, basic and No. 2 foundry, $17.

STEEL—Per gross ton, base prices, Pittsburgh, billets and slabs, $31; plates and structural shapes per 100 lb., $1.60@$1.65; soft steel bars, $1.60@$1.75.

COKE—Per ton, Connellsville furnace, $2.40@$2.50. Connellsville foundry, $3.50@$4.85; Birmingham, $3.50@$4.50. Byproduct coke, Ohio and Kentucky (Connellsville basis), $5.50; Buffalo and Detroit, $8@$8.50; Birmingham, $5.

[1]Price furnished by Foote Mineral Company, Philadelphia.



THE necessity for lower operating costs and assurance against production delays make it imperative that plant operators insist on the best in modern machinery practice.

An example of the superiority of alloy steel over plain steel is fully demonstrated by all types of crushers where granite, ganister, trap rock and similar abrasive materials take their yearly toll of mandels, concaves, bearings, crushing heads, discharge spouts and all parts subjected to the wear, strain and impact of these operations.

Alloy Steel has greater strength and affords extraordinary resistance to abrasion, impact, distortion and fatigue—increasing the life of parts and equipment many fold.

Electromet engineers will be pleased to point out the proved economies of Alloy Steel. Write for additional facts of interest.

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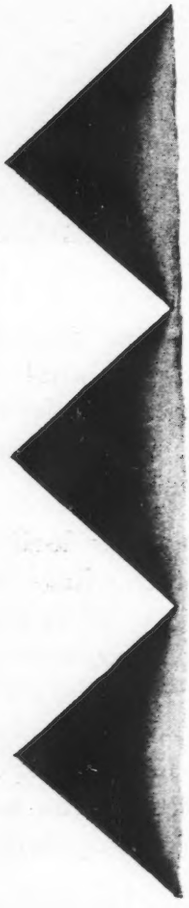
Electromet
Ferro-Alloys & Metals

Here's a New Year's Resolution for mine executives and engineers!



Probably you are proud of your mine, its year's production in spite of difficulties, its growing list of modern equipment. Yet, in common with many mines and other industries, perhaps you have not revised your lubrication policy to keep pace with your modern equipment and methods.

MANY industrial companies still have an unspoken lubrication policy of "avoiding trouble" —a hang-over from more primitive days of simple machinery and much muscle labor.

The modern lubrication policy sets a standard of "largest results at lowest costs" from each machine. Merely because you seldom hear a bearing scream for oil, or have a serious breakdown that delays production, is of course no sign you are getting correct lubrication according to best modern practice.

Vacuum Oil Company lubrication engineers, analyzing machine operation in all kinds of industry around the world, have found that undiscovered friction costs more than the friction that reveals itself by causing trouble—in most industrial companies.

You have probably intended for a long time to get hold of a Vacuum man to go over your lubrication with you. Now's the time. May we suggest a New Year's resolution to ask the Vacuum Oil Company for information as to the modern way of figuring complete lubrication costs?

On request we will send you, without obligation, one or all of these authoritative treatises on lubrication. You will find them useful in obtaining the maximum of lubrication efficiency in your plant.

Bearings and Their Lubrication
Air Compressor Lubrication
Stationary Steam Engines
Machine Shop Lubrication
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BRANCHES AND DISTRIBUTING WAREHOUSES THROUGHOUT THE WORLD

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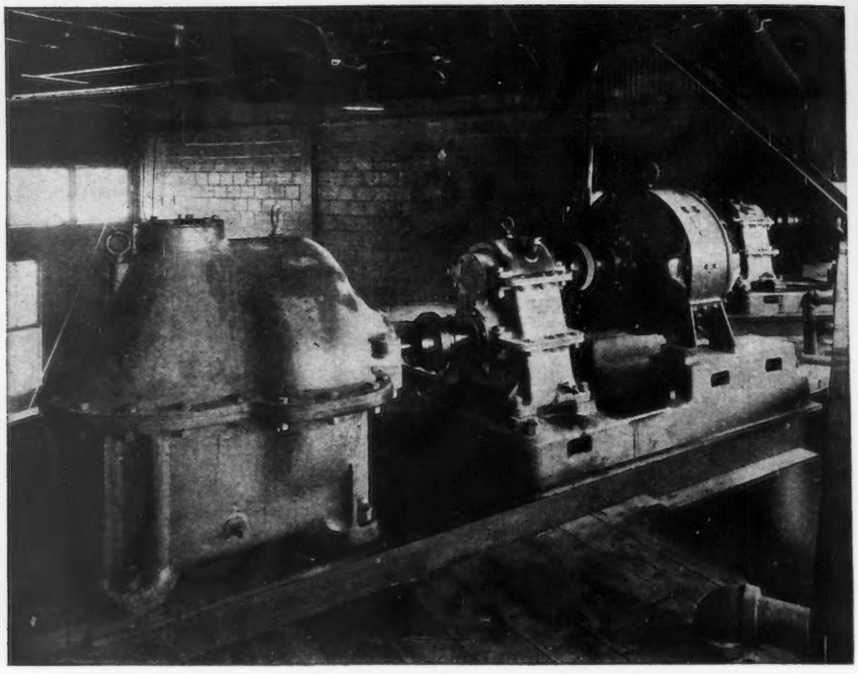
REDUCTION GEAR UNITS



Westinghouse-Nuttall Reduction Gear Unit specially designed for agitator drive in a prominent refining and smelting plant.

made to order . .

TAKE the case a few months ago in an Eastern plant of a large smelting and refining company, where unusual operating conditions necessitated the use of a specially built gear drive.

As many other concerns have done under similar circumstances, this company availed themselves of the knowledge and experience of Westinghouse-Nuttall engineers to obtain a satisfactory solution to their drive problem. The solution was the combination Westinghouse-Nuttall gear unit shown in the illustration. Later, Westinghouse-Nuttall engineers again assisted in developing a second type of agitator drive unit.

Puzzling speed reduction problems need cause you no concern. Put them up to Westinghouse-Nuttall engineers, who offer you the benefits of forty-odd years' experience in designing, building, and applying successful gear drives for mining and industrial purposes.

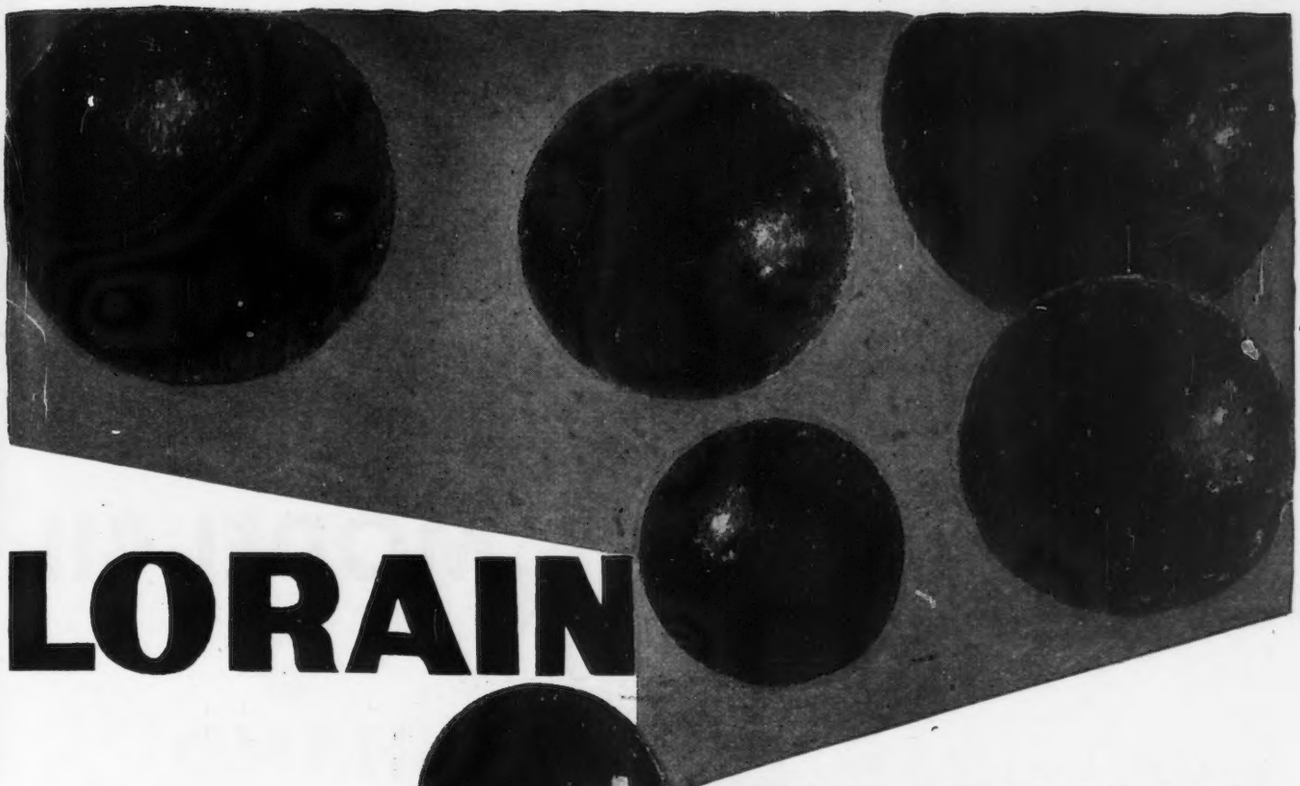
And remember, too, that Westinghouse is the only manufacturer that can serve your entire drive requirements—motors, control, flexible couplings, and gear units—with undivided responsibility. Call our nearest district office.

Service, prompt and efficient, by a coast-to-coast chain of well-equipped shops

Westinghouse

T 31639

TUNE IN THE WESTINGHOUSE SALUTE OVER THE N. B. C. NATION-WIDE NETWORK EVERY TUESDAY EVENING.



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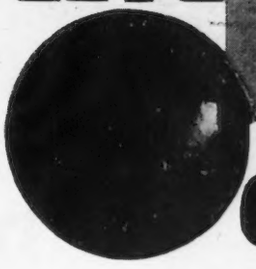

FORGED *Steel* HEAT-TREATED GRINDING BALLS

SIZES

¾", ⅞", 1¼", 1½", 1¾", 2", 2½", 3", 3½", 4", 4½", 5".

FORGED, Heat-Treated Grinding Balls made from high carbon steel stock in all diameters from ¾-inch to 5 inches. The steel stock is rolled to definite specifications in accordance with standards of the A. S. T. M. as relates to "crop," discard and chemical variants. Maintenance of these strict standards results in balls of maximum grinding efficiency and long wear.

All processes from the mining and smelting of ore to the production of finished balls are under our direct control—a condition which insures absolute uniformity of quality with a definite Brinell hardness and toughness so essential for maximum service.

All sizes of balls common to cement and ore grinding are carried in stock for immediate shipment. A large stock at Johnstown, Pa. A smaller quantity in assorted sizes is carried in stock at Denver, Col., for prompt shipments in less than carload lots.

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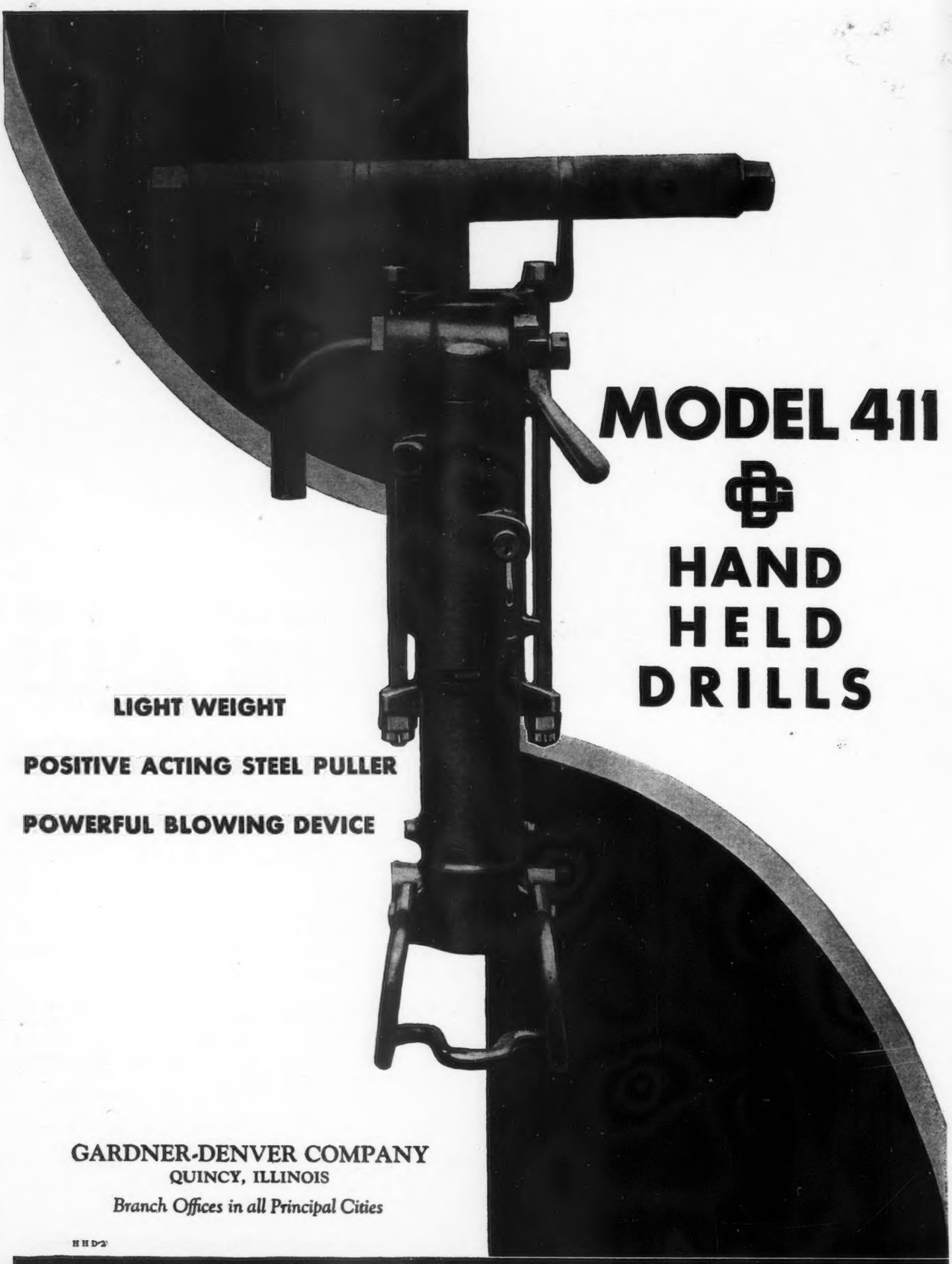
***Pacific Coast Distributors:*—Columbia Steel Company, Russ Building, San Francisco, Calif.**

***Export Distributors:* United States Steel Products Company, 30 Church St., New York City, N. Y.**



MODEL 411

HAND HELD DRILLS

LIGHT WEIGHT

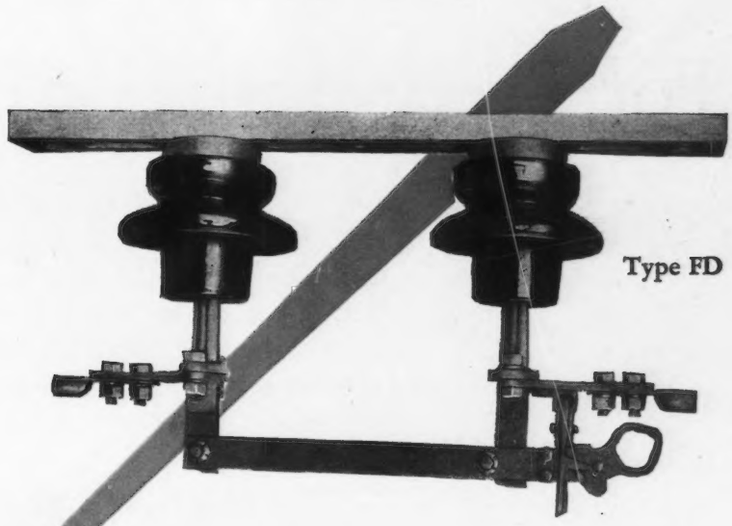
POSITIVE ACTING STEEL PULLER

POWERFUL BLOWING DEVICE

GARDNER-DENVER COMPANY
QUINCY, ILLINOIS
Branch Offices in all Principal Cities

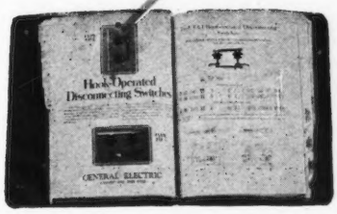
HHD-2

GARDNER-DENVER



Type FD

NEW a moderate-duty moderately priced outdoor switch



For detailed information, refer to Publication GEA-1186

GENERAL Electric offers a hook-operated outdoor disconnecting switch with a rating of 15,000 volts, 200 amperes. The device is applicable to 6600-, 11,000-, and 13,200-volt circuits, and is arranged with slotted mounting holes in a channel-iron base to permit variation in cross-arm spacing.

It is available with or without blade latch, and is furnished with assembled insulator units which are comparable to line insulators with ratings of 22 kv.

The contact is of the tongue type, the blade consisting of two laminations of hard drawn switch copper. This produces consistently high contact pressure and provides high conductivity.

The Type FD conforms to the same standards which characterize other outdoor switching equipment of General Electric manufacture. It differs only in that it is of lighter construction—a moderate-duty switch at an economical price.

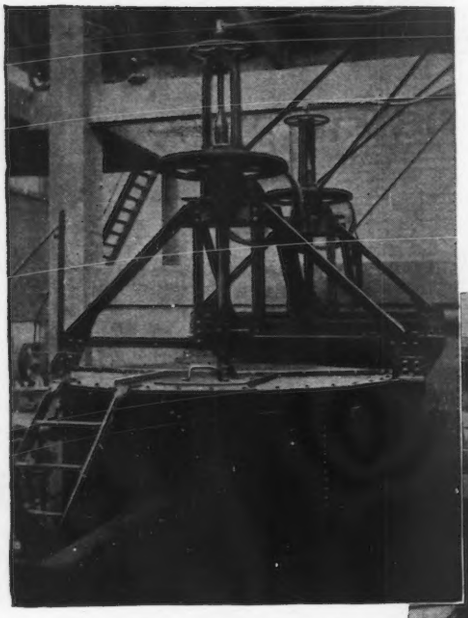
JOIN US IN THE GENERAL ELECTRIC PROGRAM, BROADCAST EVERY SATURDAY EVENING ON A NATION-WIDE N.B.C. NETWORK

500-45

GENERAL ELECTRIC

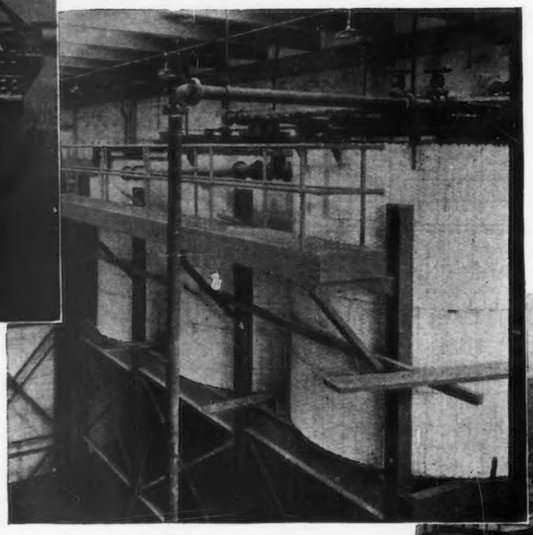
SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

For Every Agitation Need

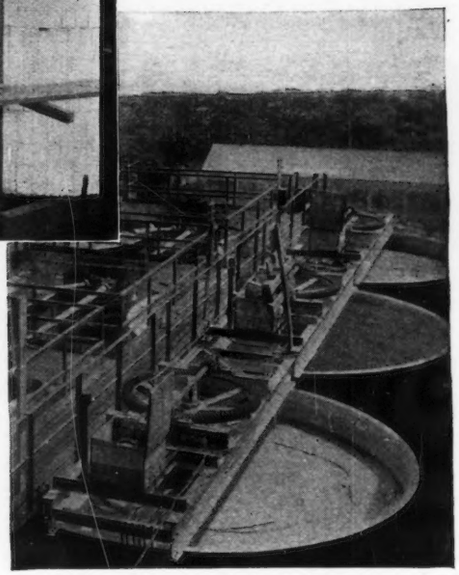


The Dorr Agitator—a combination air-mechanical agitator, for quick and thorough mixing of liquids and solids or of liquids and liquids

PERHAPS you know The Dorr Company chiefly through its thickening, washing, classifying or filtering equipment. Just let us remind you that when you are thinking of agitation or mixing, The Dorr Company can offer you three distinct types of machine, designed to answer most agitation problems.



The Dorr Impeller Agitator—a distinctly different type of agitator, used where the introduction of air is detrimental to the process



The Dorr Slurry Mixer—for heavy duty work or for use in large storage basins

The performance of all three types of Agitator is notable for rapidity of mix, and low power consumption.

Our nearest office will gladly forward bulletins.

The Dorr Agitator,	Bulletin 1081
The Dorr Impeller Agitator,	Bulletin 1271
The Dorr Slurry Mixer,	Bulletin 1181

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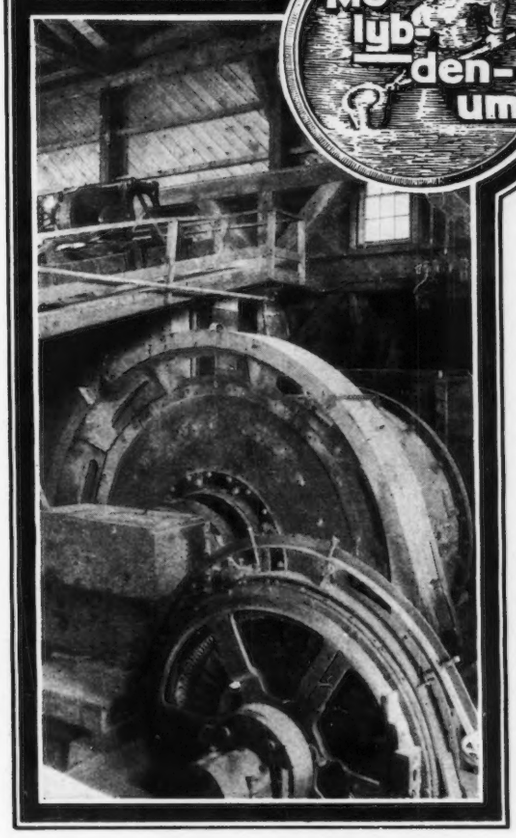
JOHANNESBURG, S. A
E. L. Bateman
Locarno House

Climax Molybdenum Installs Large Marcy Ball Mill



A LARGE Marcy Ball Mill has recently been put into operation by the Climax Molybdenum Company at Climax, Colorado, to receive a ¾" discharge from the crusher and in "One Easy Step" to give a classifier overflow suitable for flotation feed.

We take particular pride in the installation of this large mill because of the fact that it is the direct result of the highly satisfactory performance and low grinding costs obtained from the operation of Marcy Ball Mills at the associated plants of the American Metal Company at Glorieta, New Mexico, Compania Minera de Penoles, S. A., Mexico, and Minas de Matahambre, S. A., Cuba.

This is just another of the many instances in which the complete satisfaction given by the first installation of Marcy Mills has led to subsequent repeat orders.

This large Marcy Ball Mill is constructed almost entirely of cast steel. It has detachable steel head, steel trunnions, and steel shell with two manholes of generous size. The spiral shell liners are of manganese steel.

Our engineers are interested in your grinding problems and will welcome the opportunity of discussing with you the merits of Marcy design and construction. Write for our Ball Mill Catalog.

The MINE and SMELTER SUPPLY COMPANY

MARCY MILL DIVISION

DENVER, COLORADO, U. S. A.

EL PASO, TEXAS
410 San Francisco St.

NEW YORK CITY
225 Broadway

SALT LAKE, UTAH
121 West 2nd, South

MASSCO

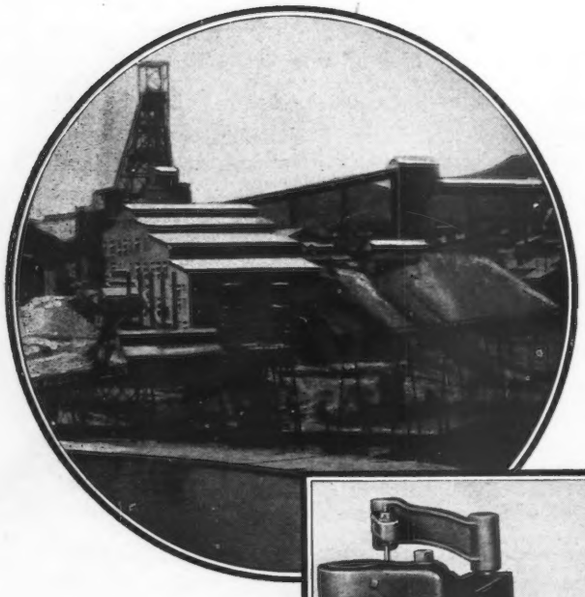
More *Operating Hours* From the WILFLEY Sand Pump

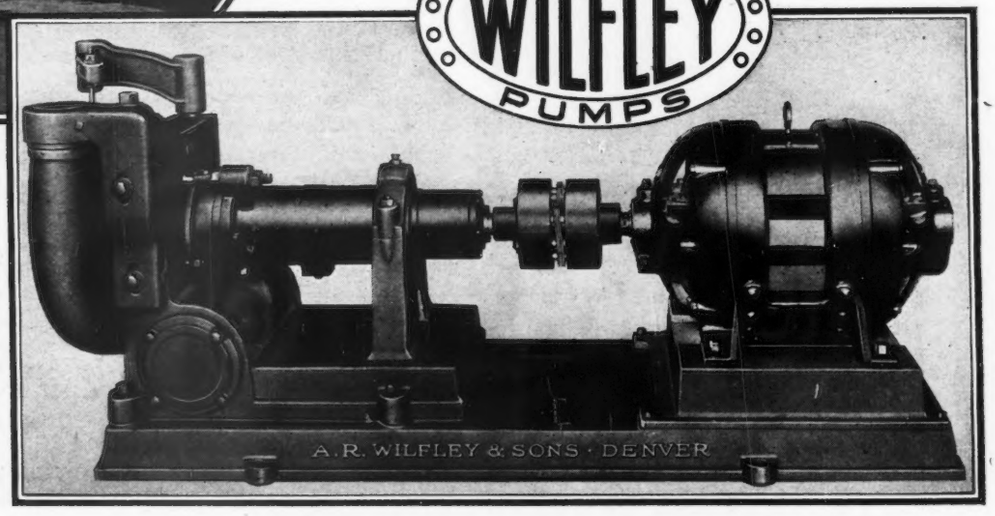
EVALUATE these time-saving features of the Wilfley Centrifugal Sand Pump:

1. No stuffing box, hence no time out for such maintenance work.
2. Extra heavy pumping parts to provide longer life.
3. Easy take-up of clearances to maintain capacities and to reduce wear of parts to a minimum.
4. Shaft protected against gritty sludges, hence infrequent shaft renewals.

The sum of these Wilfley advantages means little time out of service—a lot of time in service.

The Wilfley will give you low-cost pumping. In a large measure this is due to its greater number of ***operating hours.***





A. R. WILFLEY & SONS, Inc.
P. O. Box 2330
DENVER, COLO., U. S. A.

WILFLEY Centrifugal SAND PUMP
PATENTED

THE PICK OF THE PACK

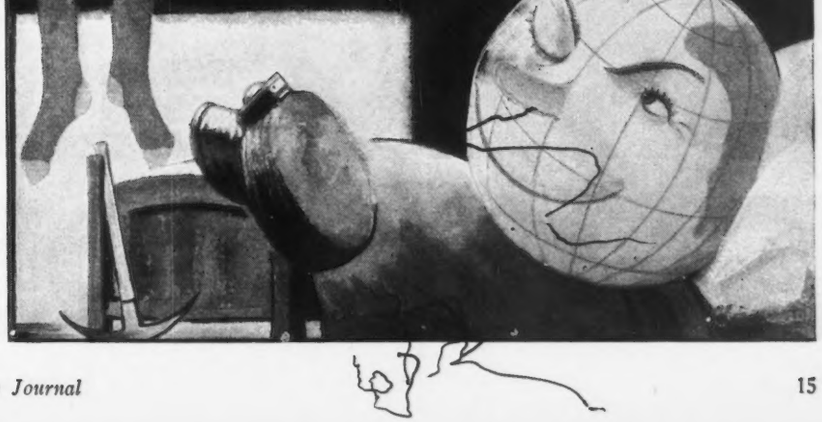
TO EVERY MILL WHERE THE ORDER IS HIGH RECOVERIES, THE BEAR BRINGS THE PICK OF THE PACK FOR FLOTATION PERFORMANCE. WHERE THE GOING IS TOUGHEST, THE BEAR PULLS THROUGH...SMILING! FOR EVERY JOB HE HAS A REAGENT THAT KNOWS ITS ORES AND HOW TO FLOAT THEM. WHEREVER THE NEED, WHATEVER THE JOB, THE BEAR HAS A XANTHATE TO PULL YOU THROUGH . . . Z-3 POTASSIUM XANTHATE, Z-4 SODIUM XANTHATE, Z-5 AND Z-6 AMYL XANTHATE, Z-7 BUTYL XANTHATE.

WITH A CHRISTMAS GREETING, THE BEAR BRINGS THE LATEST AND BEST IN REAGENTS FOR THE BATTLES OF THE COMING YEAR.

BEAR BRAND XANTHATE FLOTATION REAGENTS

GREAT WESTERN ELECTRO-CHEMICAL CO.

9 Main Street, San Francisco. Plant, Pittsburg, California. Cable Address "Chlor"



S17

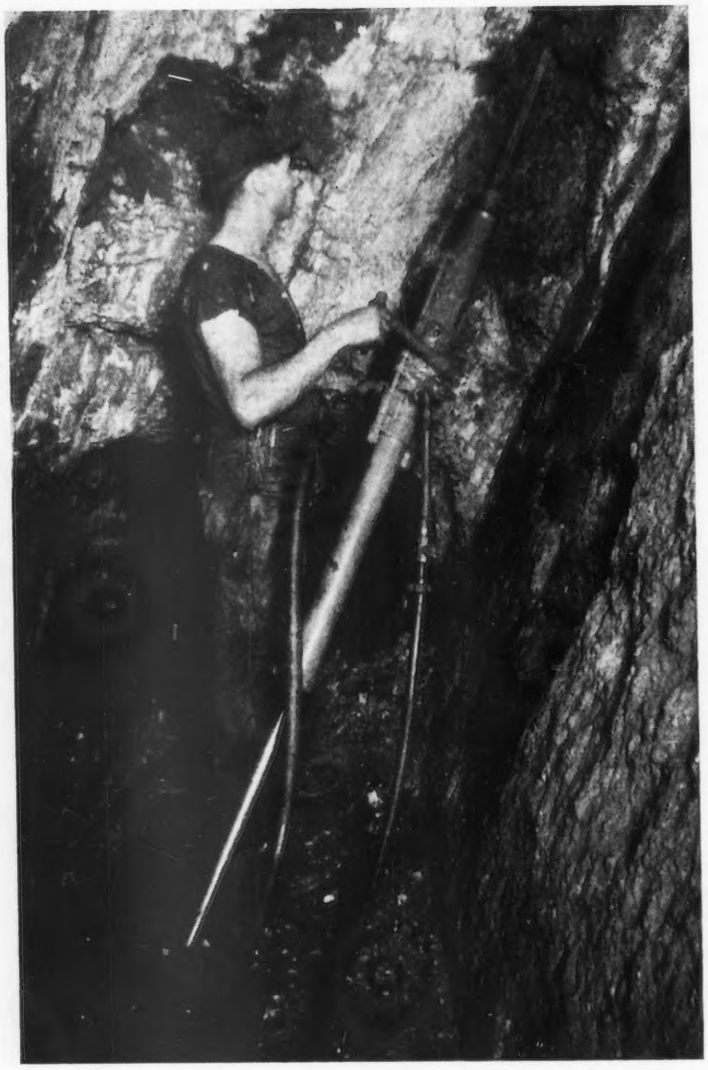
The Step Ahead Stoper

Outstanding Trip Rotation

Perhaps outstanding among many unusual improvements incorporated in the Cleveland S17 is "Trip Rotation."

With this device—by a twist of the hand grip on the rotating handle — the drill runner can stop rotation at will. This permits operating the hammer on light air when "collaring the hole," as the automatic rotation is not effective.

Also the operator may stop or start rotation as often as he likes, an obvious advantage where the rock face is irregular or angular. With "Trip Rotation," too, "rifling" of holes may be prevented.



Notable Features

S17 has many other notable improvements. Its power of rotation is unusual. It has an improved air feed control to weaken the air feed in fissury or soft ground. It is provided with a special type of lock nut that virtually eliminates loose bolts. Maintenance and overhauling are reduced.

The throttle is so arranged that it always blows the hole after the water is shut off. The drill is thus kept clear of water, rust is minimized.

Let us tell you more about the S17 Stoper and demonstrate it on your property.

The Cleveland Rock Drill Company
3734 East 78th St. Cleveland, Ohio

Branches, Agents and Service Stations in Principal Cities and Mining Centers of the World.

CLEVELAND ROCK DRILLS

Watt Steel Heavy Duty Two-Way Dump Rocker Car. Timken Roller Bearing Wheels. Capacities 18 to 80 Cu. Ft. No. 1524 AW.

All Steel Granby Type Car—for automatic dumping. Capacities 2 to 5 Yds. No. 711J

Watt Steel Rocker Dump Tram Car. Capacities 18 to 40 Cu. Ft. No. 1062W.

Watt Steel (or wood) Standard Square Body Two-Way Side Dump Car. Capacities 3 Cu. Yds. and up. No. S-1761W.

Watt Steel Heavy Duty Two-Way Side Dump Car for Hoist Dumping. Capacities 3 to 8 Cu. Yds. No. S-1747W.

Watt End Dump Quarry Car—latest type—heavy construction. Type of couplers optional. Capacities 2 to 5 Yds. No. 950CJ.

MODERN EQUIPMENT

Reduces Haulage Costs

Progressive mining companies speed up haulage and reduce costs with modern equipment.

Watt cars are modern.

They are designed and built for power, haulage and for long life, large capacity, fast dumping, low maintenance.

Watt engineers will be glad to consult with you and suggest the type of car best adapted to your needs.

Watt Steel Gable Bottom Car. Capacities 25 to 100 cu.ft. No. 1067W.

The WATT CAR & WHEEL CO., Barnesville, O.

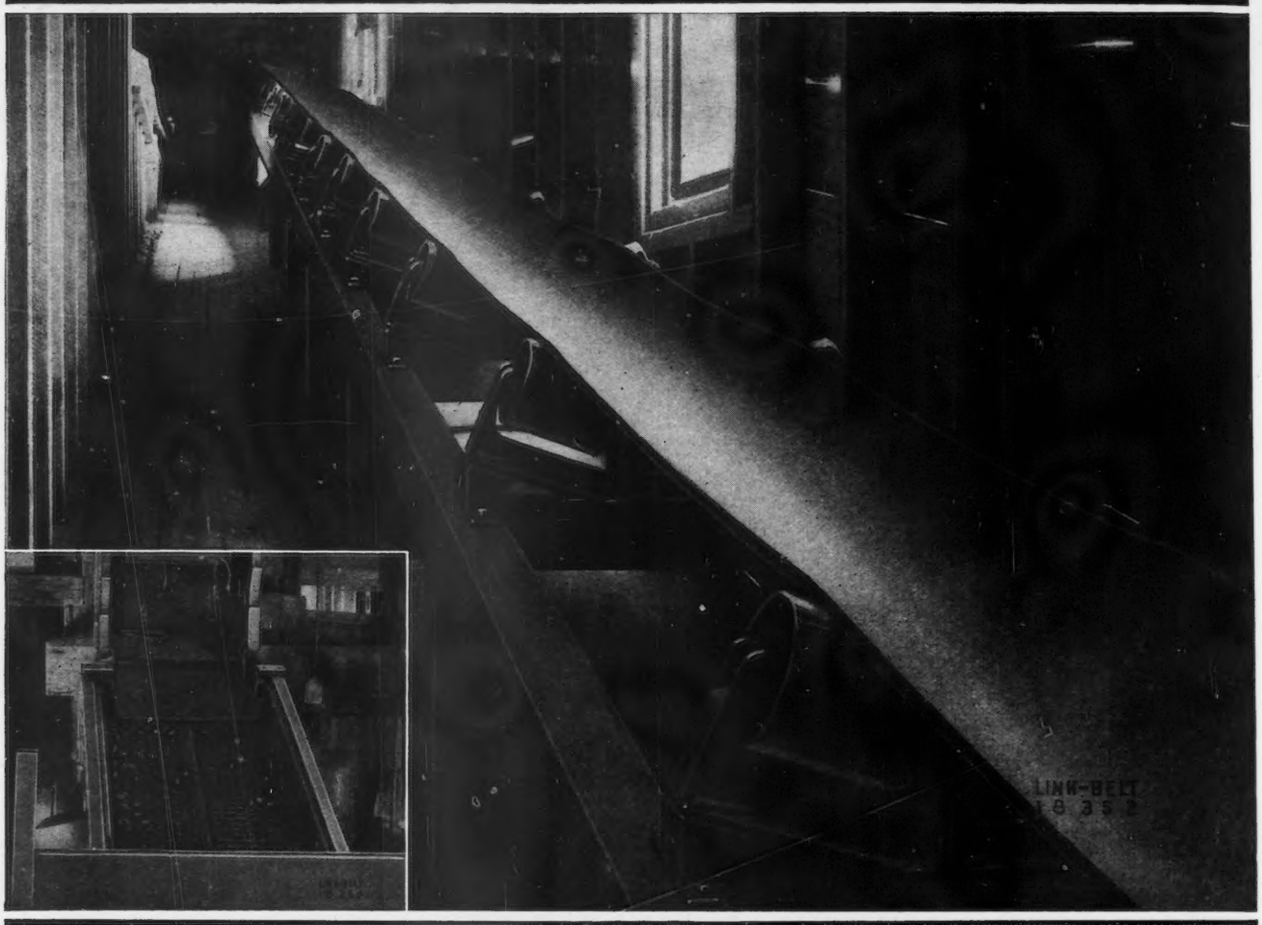
Birmingham, Industrial Supply Co., Brown, Marx Bldg.
Chicago, B. E. Schonthal & Co., Inc., 224 So. Michigan Ave.
Denver, Lindrooth, Shubart & Co., Boston Bldg.
Huntington, J. E. Graham, 341 Twelfth Ave.
New York, C. R. Gier Co., 66 Beaver St.
Pittsburgh, W. C. Wilson, 1135 Greenfield Ave.

Watt Steel Three-Way Standard Ore Dump Car. Capacities 12 to 30 Cu. Ft. No. 1132W

WHEN *requesting quotations, please state track gauge, capacity desired, total weight on four wheels and any limiting dimensions vital to your operation.*

Watt Steel Skip Car. Built to capacity and gauge desired. Dimensions to fit your shaft. No. 1103.

"The Best that Money Can Buy"



Another Northern Ontario Mine that is Link-Belt Equipped

IN the plant of Vipond Consolidated Gold Mines Ltd., Timmins, Ont., a Link-Belt Anti-Friction Belt Conveyor in the crusher houses delivers material to a Link-Belt Vibrating Screen.

Like many another Canadian gold mine, Vipond has found that Link-Belt equipment is the best that money can buy, and that the best is cheapest in the long run. Especially is this true of the more severe services found in the industry, where inferior installations lead to frequent and costly replacements.

Link-Belt makes everything for the economical elevating and conveying of materials, and the efficient transmission of power in the mining industry, and all this equipment is backed by years of satisfactory service in the field.

Send for complete catalogs

3941

LINK-BELT COMPANY

Leading Manufacturers of Equipment for Handling Materials Mechanically and for the Positive Transmission of Power

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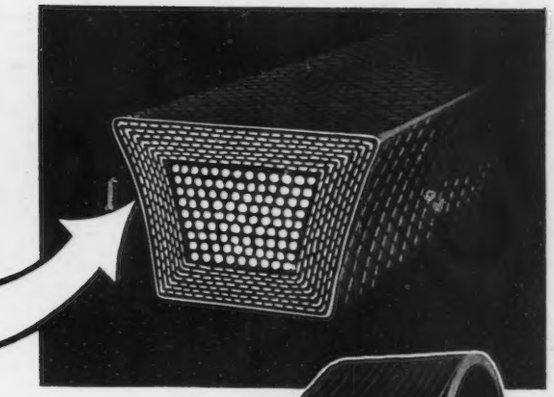
Atlanta, Baltimore, Birmingham, Boston, Buffalo, Cleveland, Dallas, Denver, Detroit, Grand Rapids, Kansas City, Mo., Los Angeles, Louisville, Milwaukee, Montreal, New Orleans, New York, Oakland, Pittsburgh, Portland, Ore., Seattle, St. Louis, Toronto, Vancouver, Wilkes-Barre

LINK-BELT ANTI-FRICTION BELT CONVEYORS

THAT Concave Side



Is Saving Dollars for Factories Everywhere

Every engineer knows that when a V-Belt bends around a pulley the top of the belt comes under *tension* and therefore *narrows.* The bottom comes under *compression* and naturally *widens.* The sides of the belt *bulge out.*

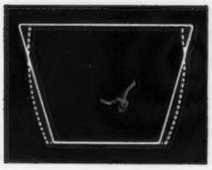


Fig. 1

The ordinary straight-sided belt is therefore forced to assume, in the sheave groove, the shape shown by the dotted lines in figure 1.

Two faults result: (1) The bulging causes uneven wear on the sides of the belt—*shorter life!* (2) The entire side of the belt does not uniformly grip the pulley—*a loss in drive efficiency.*

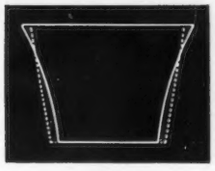
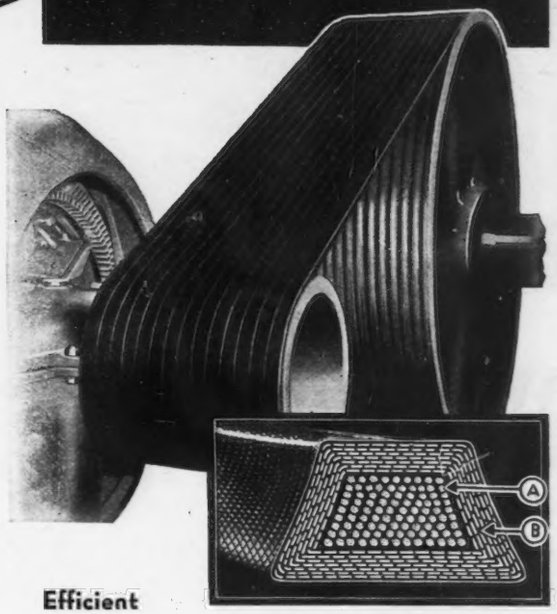


Fig. 2

Contrast the belt designed with the accurate concave side (patent pending) — the Gates Vulco Rope. As this belt bends, it assumes a shape that *exactly fits* the sheave groove. (Fig. 2). Two advantages: (1) Wear is evenly distributed over the entire side—*longer life!* (2) The whole side-width uniformly grips the pulley — *full delivery of power!*



Efficient
Silent
Clean
Compact
Durable
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Patented Construction

U. S. Patents 1,354,738 and 1,400,-539 protect both the principle and construction of a V-Belt having a core of endless cords (for strength) with a bias-woven cover (protecting the cords and giving pliability and long wear).

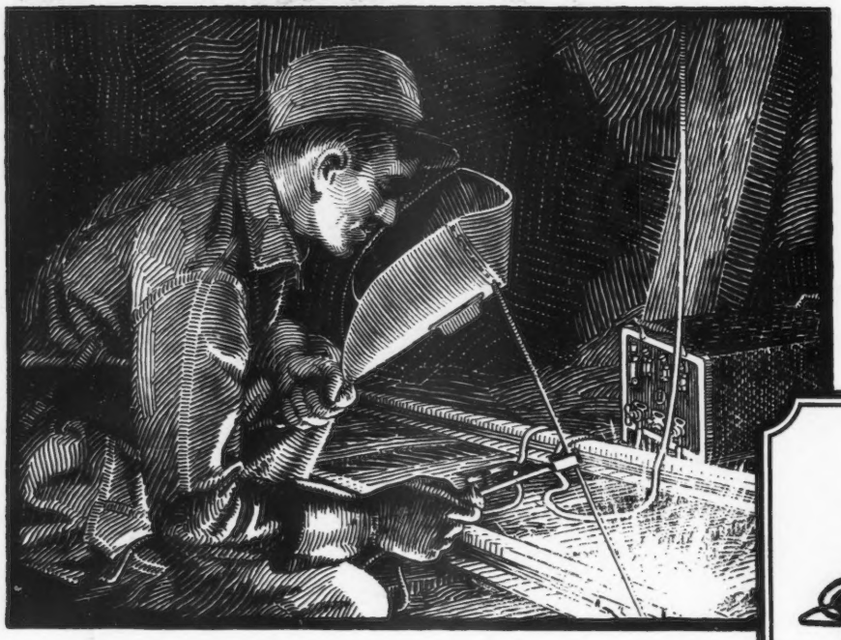
Send for This Helpful Book Today!

Without obligating you, our Engineering Department is prepared to handle the entire problem of a drive design that efficiently meets your needs. This book, sent free, is a valuable preliminary guide. Send for it today.

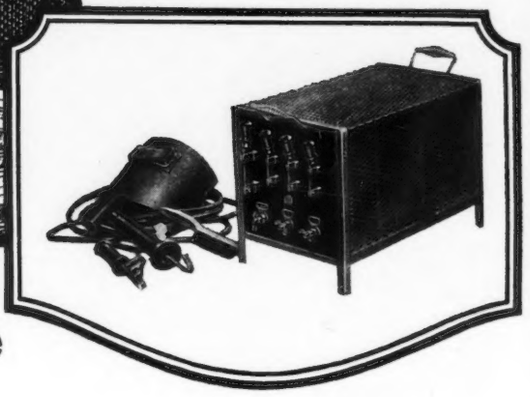
GATES VULCO ROPE

MULTIPLE V-BELT DRIVES

Manufactured by Gates Rubber Company, Denver, Colorado,—The World's Largest Manufacturers of V-Belts



KEEPING DOLLARS FROM WAITING ON DIMES



What the Profit-Wise Man Will Do

IN HIS plan of using better rail bonds and the proper welding rod to "keep dollars from waiting on dimes", the profit-wise mining man will not over-look the advantages to be gained through using a good welding machine.

A good welding machine enables the welder to control the welding current effectively, and enables him to make more good welds per hour of work. Welders, wise in the ways of good bonding, select the O-B Lightweight Welder for their work. This machine weighs only 55 lbs., and can be handled easily by one man. It has ample current capacity, and operates with thoroughness on voltages ranging from 175 to 275 volts. Current regulation is simple. Three single-pole knife switches give a choice of welding current from 30 to 210 amperes. Heavy nickel-chromium resistance wire and special insulating features put repair and replacement bills out of the immediate future into a time long after the machine has paid for itself.

Ohio Brass Company, Mansfield, Ohio
Canadian Ohio Brass Co., Limited
Niagara Falls, Canada
1241M

Small But Mighty

The O-B Lightweight Welder is small, easy to handle, but it is mighty enough for the hardest bonding work. Unit construction plus a special arrangement of insulators and coils keeps the coils from grounding. Fully described, page 84, O-B New Products Supplement No. 4.

NEW PRODUCTS
Supplement No. 4

Ten new money-saving mining devices are shown in this new O-B Catalog Supplement. Are you familiar with these? Leaf through this booklet frequently. You will find it well worth the time.

Ohio Brass Co.

NEW YORK PHILADELPHIA PITTSBURGH BOSTON CHICAGO CLEVELAND ST. LOUIS ATLANTA DALLAS LOS ANGELES SAN FRANCISCO SEATTLE

PORCELAIN INSULATORS
LINE MATERIALS
RAIL BONDS
CAR EQUIPMENT
MINING MATERIALS
VALVES

What's Ahead?

1930 1931

WHAT'S ahead for the men in charge of mining, milling, smelting and refining operations? 1931 will see many new projects under way, the expansion and completion of enterprises recently started, as well as continued activity in the long-established districts. The program ahead will create new sales opportunities in many parts of the world for manufacturers of mining and metallurgical equipment and supplies.

In planning 1931 activities, the men in charge of operations must have the facts, complete, regarding 1930 developments. They want, too, authoritative opinion on the outlook for the coming year. And they will require production machinery and supplies that will bring them high returns on their investment through reduced operating costs.

The Annual Review and Statistical Numbers of the February *Engineering and Mining World* and the February 9th *Engineering and Mining Journal* will sum up developments in the industry to date, forecast future activities and help to point out the equipment that will do the most to *increase net earnings.*

Each of these issues will be a volume of facts and opinions collected from all parts of the world, of immeasurable help to the industry in planning the job ahead . . and a valuable reference book for use throughout the coming year.

Engineering and Mining World will interpret this fundamental information for the benefit of its audience in 64 countries and colonies *outside* the U.S.A.; *Engineering and Mining Journal* will interpret it for its audience throughout the U.S.A. and possessions.

TIMELY EDITIONS FOR ADVERTISERS

These are the issues in which the world's leading manufacturers of mining and metallurgical equipment and supplies . . those selling to enterprises located outside the U.S.A., and those selling to enterprises located within the U.S.A. . . may give prominence to the part their products will play in lowering production costs and building profits for the industry during the coming year.

Mining men the world over are in the market for everything that can help them build net earnings through reduced operating costs and increased output.

CLOSING DATES . . February Annual Review and Forecast Number, *Engineering and Mining World:* Last advertising forms close in New York . . January 21st; February 9th *Engineering and Mining Journal:* Last advertising forms close in New York . . January 26th.

Engineering and Mining Journal

Engineering and Mining World

McGraw-Hill Publications

Tenth Avenue at 36th Street New York, U. S. A.

"Judge for Yourself Don't You See That . .

Above—Mr. Irvin Reed, President and Manager of the Pacific Coast Rubber Company of San Francisco, California. This company's services are of a definite economic value to the prosperity of its business territory.

THERE is no more direct route for merchandise to flow in than through houses of our kind. Regardless of the name or type of distributor they must absorb our functions and our costs of selling. Our strength and value is predicated on the common sense way in which this point is viewed."

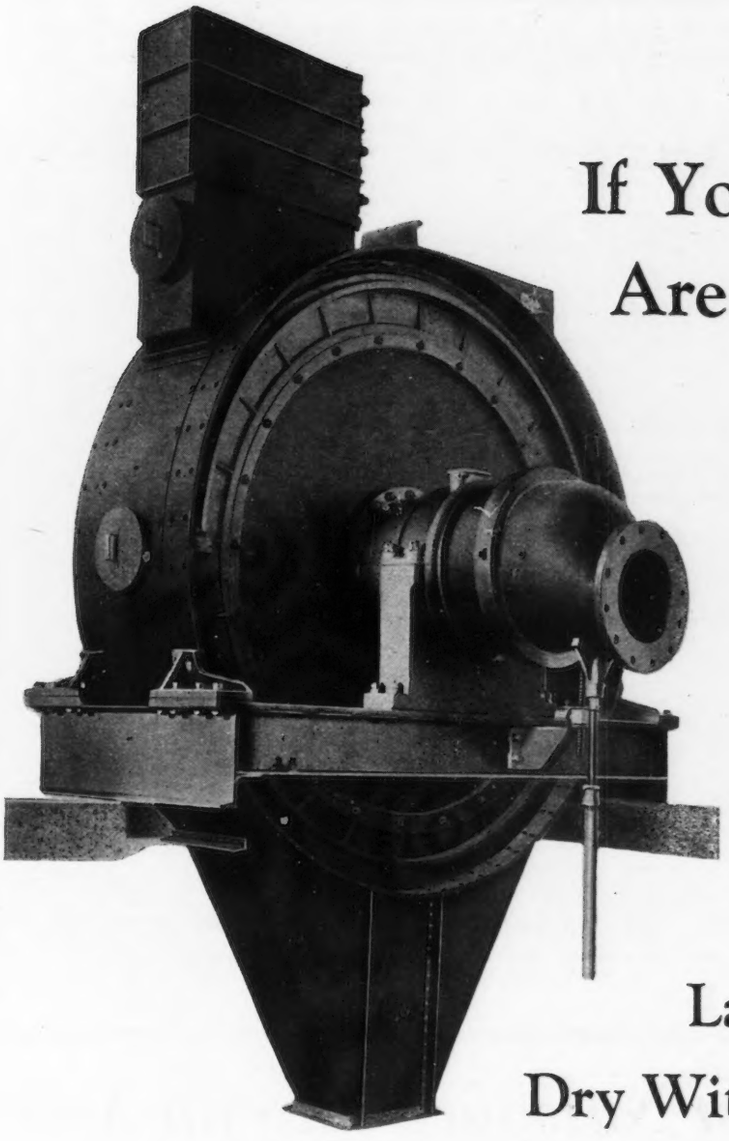
The above statement is characteristic of those made by prominent distributors all over the country. It explains in part how the Industrial Supply Distributor, helping to solve the important problem of broad markets and economical distribution, upholds high quality, maintains fair prices and saves needless efforts on the part of both consumer and manufacturer.

Invader Belting is as old as is Republic (28 years.) Invader will work satisfactorily anywhere, except on abnormal drives calling for super quality such as is in Champion High Speed.

Send for a sample of
INVADER

THE
REPUBLIC RUBBER CO.
Youngstown
Ohio

REPUBLIC means the Best Mechanical Rubber Goods



If Your Concentrates Are—

—Crystalline

—Non-slimy

—Fast-settling

You Can Filter Large Tonnages Very Dry With Little Filter Area

THE new Oliver United Top Feed Filter has two advantages that stand out like twin beacons on a clear, dark night—capacities never before heard of, and exceptionally dry cake.

The large tonnage is of interest to all mill men and the exceptionally dry cake of interest to those who must ship their concentrates some distance, or bag them, or deliver them direct to the smelter where the moisture must be driven off by costly heat.

The Oliver United Top Feed Filter is one of the most important developments in recent years. In writing for more information, tell us about your filtering problem.

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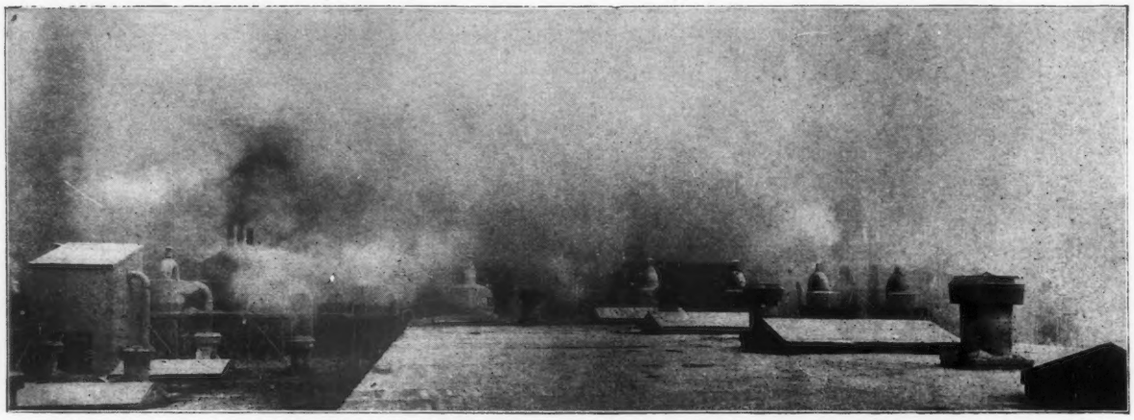
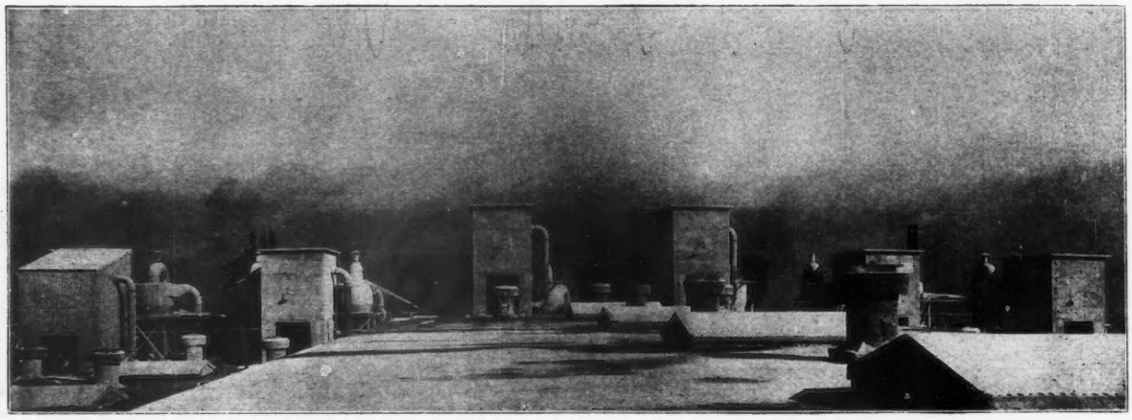


BEFORE—
A NUISANCE

Clouds of phosphate dust created a nuisance here that only Dracco filters were able to eliminate. The exceeding fineness of the dust, 84% thru 300-mesh screen, caused it to elude all previous control attempts.



AFTER—
AN ASSET

Contrast this condition with that above. Here no dust is visible—its absence represents complete elimination of a nuisance and a product recovery averaging a ton each day.

Changing a Dust Nuisance into an Asset

The ability of Dracco High Efficiency Filters to clear up the most obstinate dust conditions is demonstrated again in this installation.

Once, phosphate dust from the vents of twelve pulverizers was a constant source of nuisance to the neighborhood, created unhealthful working conditions and wasted valuable dust.

Today, with a bank of six Dracco filter units no dust discharge is visible. Troublesome dust discharge is completely eliminated and .2 per cent of total mill capacity is recovered to contribute to the over-all efficiency of the plant.

Throughout the metallurgical fields—wherever dust and fumes create a nuisance, a health hazard or a loss of material—Dracco installations are proving the solutions to the problems.

Dracco engineers will gladly advise with you on the solution of your similar problems.

DRACCO

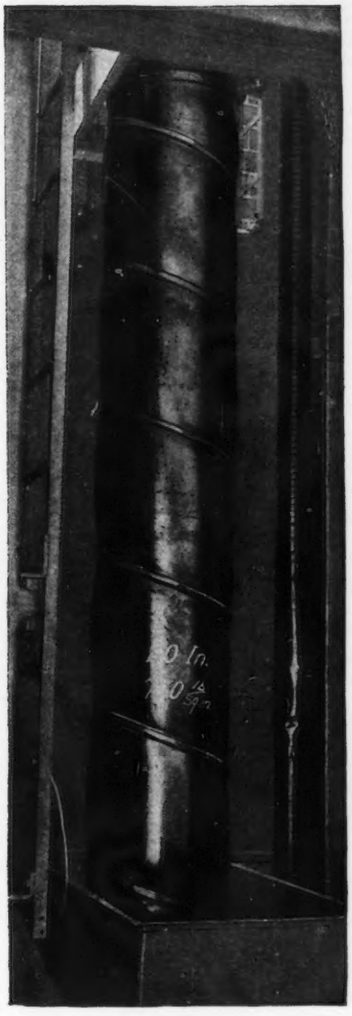
THE DUST RECOVERING & CONVEYING CO.

Engineers and Manufacturers **CLEVELAND, OHIO**

AIR FILTER FOR TREATMENT OF *Pollenair* TRADE MARK **HAY FEVER AND POLLEN ASTHMA**

LIGHT WEIGHT Naylor Pipe

Withstands High Pressures



20-inch Naylor Pipe in Testing Machine during Internal Hydrostatic Pressure Tests

No.2—Internal Hydrostatic Pressure Tests.

Every length of Naylor Pipe is tested to the pressures indicated in the following table:

Diameter of Pipe	Mill Test Lbs. per Sq. In.	Diameter of Pipe	Mill Test Lbs. per Sq. In.
6″	900	14″ O. D.	450
8″	800	16″ O. D.	400
10″	700	18″ O. D.	350
12″	500	20″ O. D.	325

Extensive tests recently made by Professor M. L. Enger and W. M. Lansford of the Materials Testing Laboratory of the University of Illinois, bear out the soundness of this practice.

In the course of these tests it was shown that the bursting strength of Naylor Pipe computed in accordance with the formula $p = \frac{2ts}{d}$ was less than the bursting strength found by experiment. This means that the Naylor Structure is definitely responsible for an increase in resistance to internal hydrostatic pressure.

Catalog 30-2 gives you complete engineering and metallurgical data.

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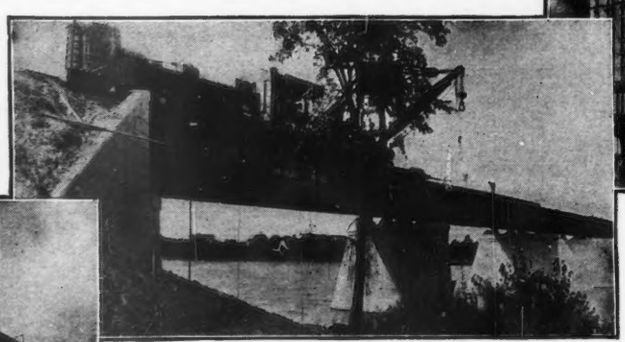

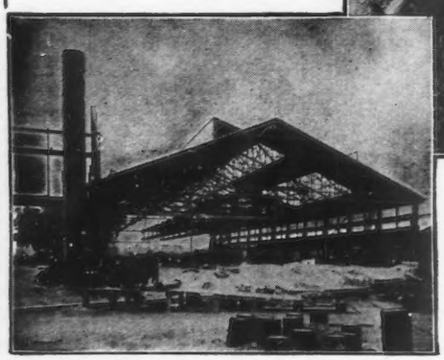

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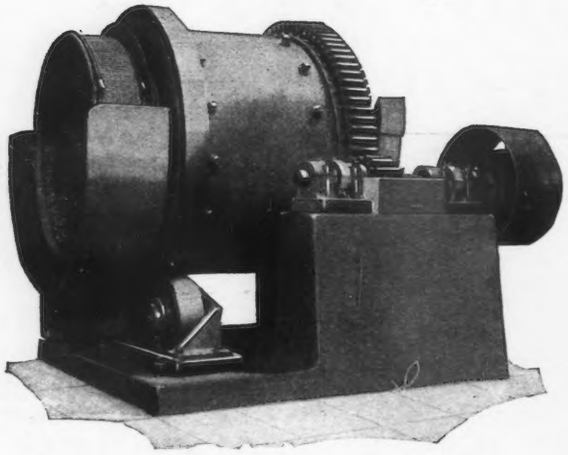

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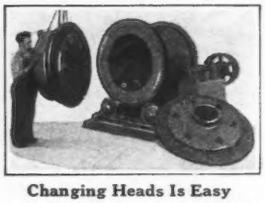

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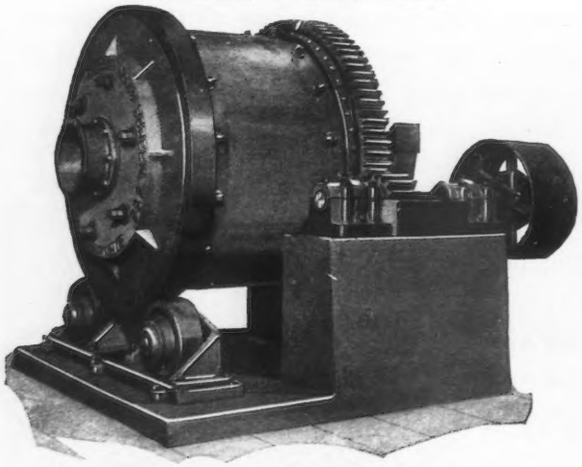

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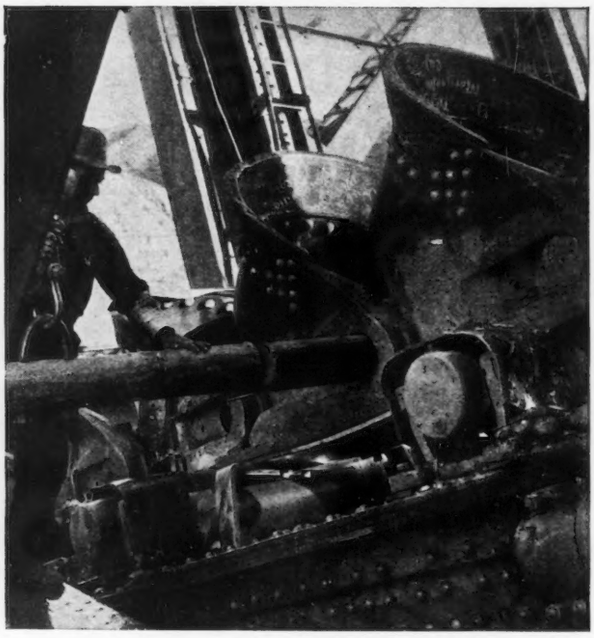

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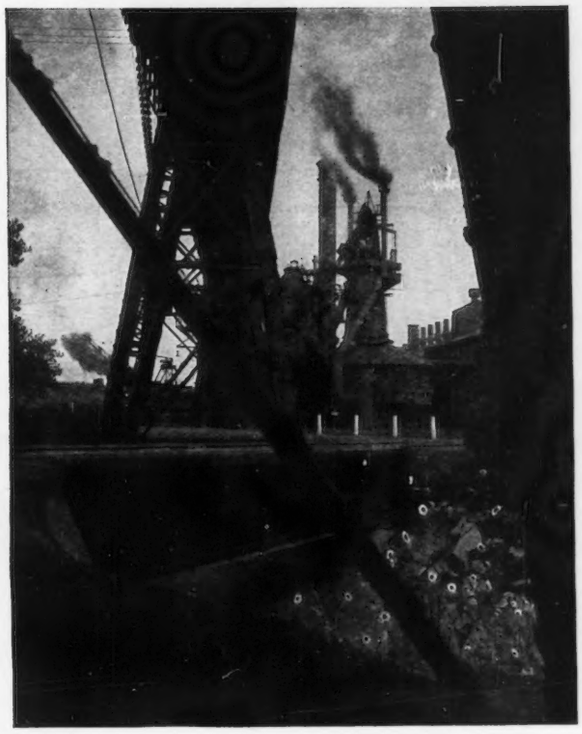

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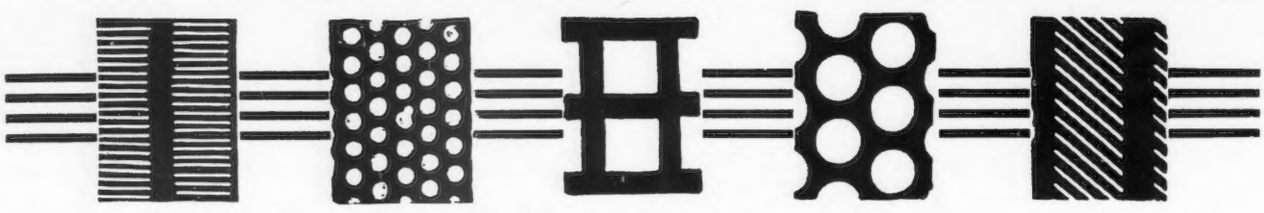

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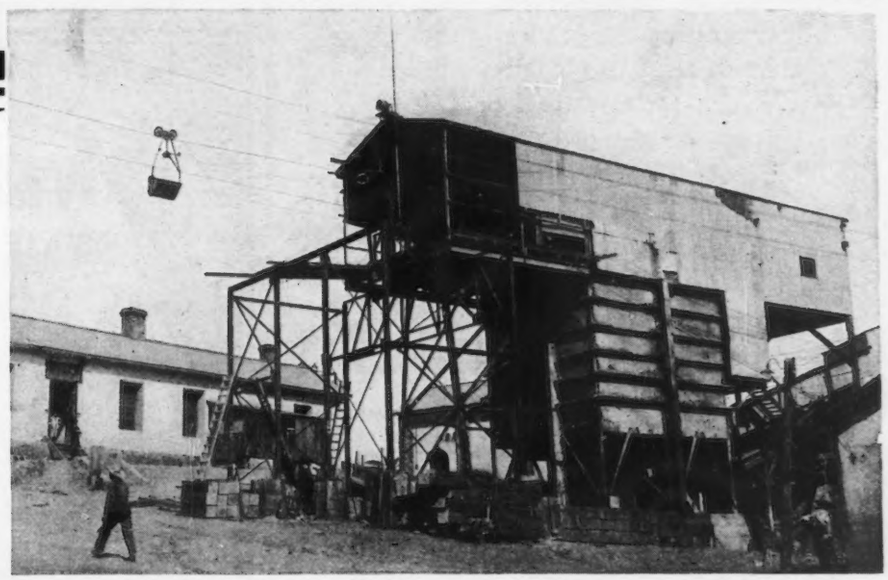

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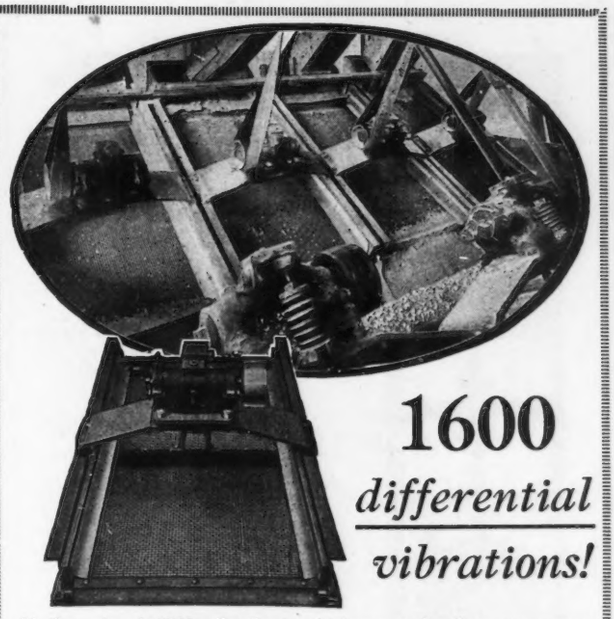

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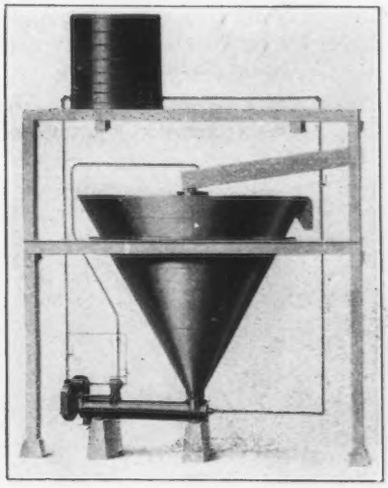
The James Classifier that is making remarkable recoveries.



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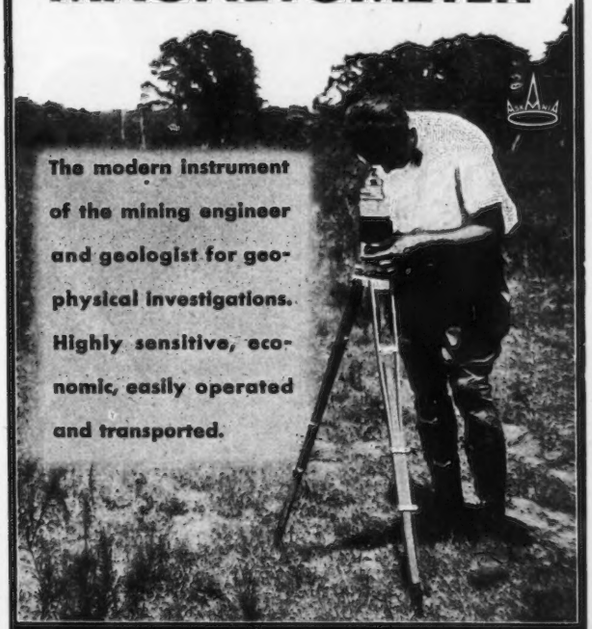

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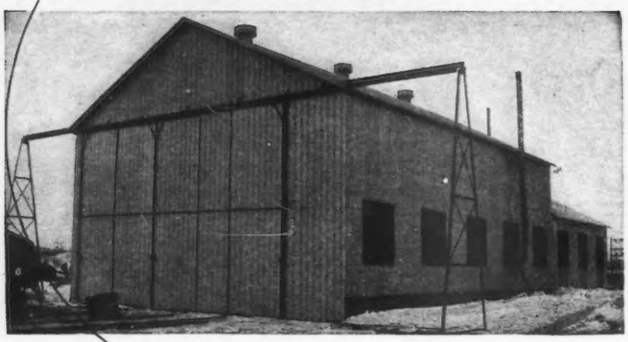

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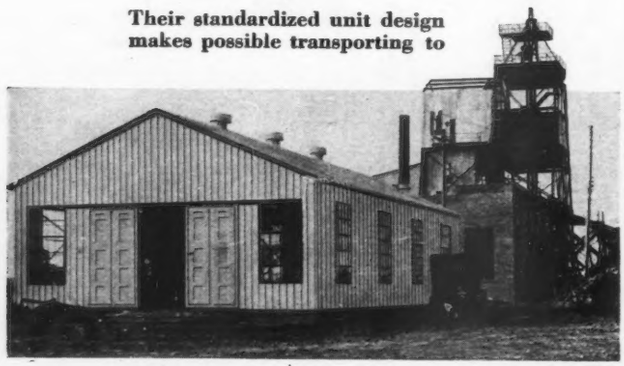

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These pumps are light weight—can be moved easily, speedily.

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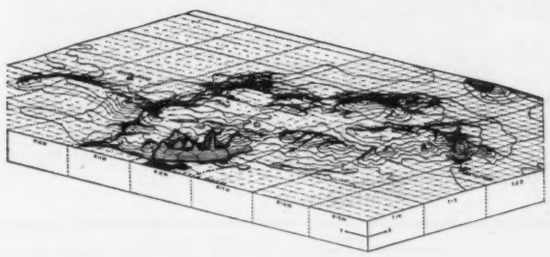

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Geomagnetic and geological surveys under the direction of Noel H. Stearn, Geologist.

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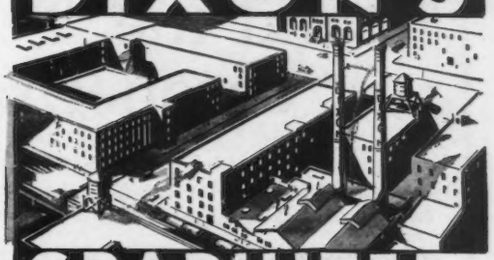

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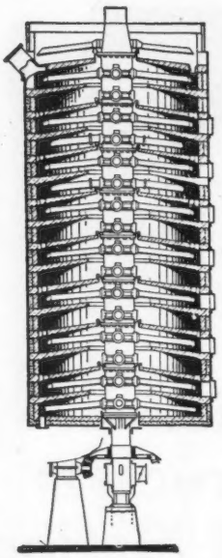

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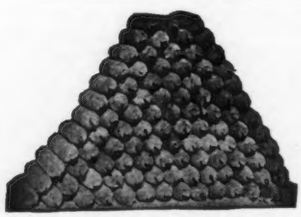

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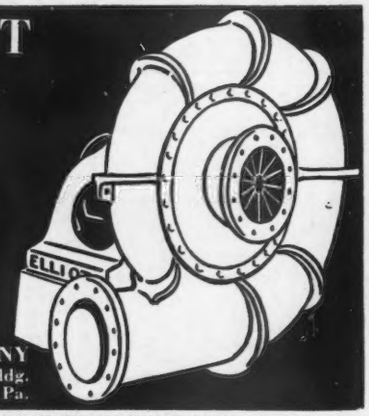

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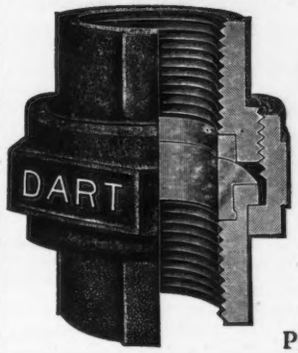

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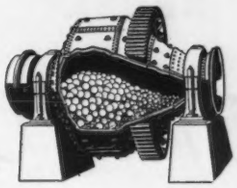

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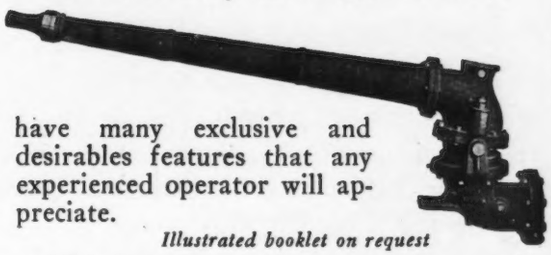

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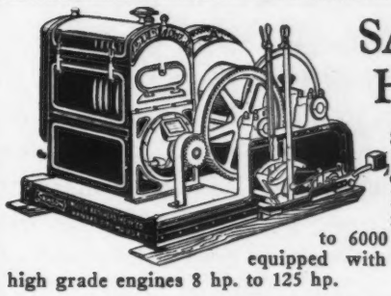

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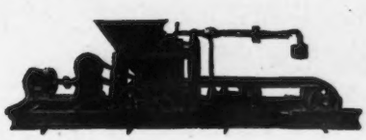

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What Price Orders . . . ?

EVERY manufacturer must make at least two products. He must manufacture the *product* he would sell; he must manufacture *orders* for that product.

In the manufacture of his product, scientific production has taught him how to cut his costs to the bone. But as *production* costs have dropped, *distribution* costs have tended to rise. New margins for saving must now be sought in the cost of *selling,* rather than in the cost of production—in the cost of manufacturing orders, rather than in the cost of manufacturing products.

Lower production costs have come through the intelligent choice of products, sound organization, larger production, the skillful selection and use of modern production tools. Lower sales costs can be achieved only through intelligent choice of markets, sound sales organization, larger consumption, the skillful selection and use of modern selling tools.

Of these last, advertising is the chief. What the modern tool is to production, advertising is to selling. The one reduces the cost of manufacturing a product; the other reduces the cost of manufacturing an order. The one makes possible larger production without excessive production cost; the other makes possible larger sales volume without excessive sales cost.

To be effective, such advertising must be wisely planned and skillfully applied. Often it will be an investment—along with the designs, patterns, jigs, dies and other tools of production—the cost of which should be spread over the business of years, constantly reducing the cost of manufacturing each order. This is an investment in a market, just as there must be an investment in a product.

As there are appropriate tools for the several processes of production, so there are advertising tools for the various needs of selling. When each of these has done its part the salesman must come to assemble their work into the finished product—*an order.* And the master salesman of today is the one who knows his tools—what they can do and how to use them. The day for bare-handed selling has passed with the day of hand manufacture. The salesman who does not know how to use advertising to cut the cost of his orders is brother to the mechanic who cannot use the modern tools of production.*

\+ + + +

The advertising section of *Engineering & Mining Journal* is one such tool for more economical selling to the mining and metallurgical industries of the United States and its Possessions, serving alike the interest of the progressive manufacturer and the user of his products—serving to aid our readers, no matter how isolated, in *efficiently* locating and obtaining the best machinery and products for all operating problems.

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* *From a recent address by Col. Willard Chevalier before the Technical Publicity Association, New York.*

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DENVER LABORATORY EQUIPMENT
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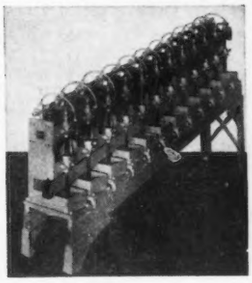

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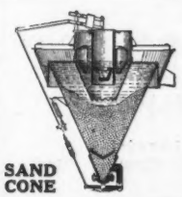

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MINING engineer, technical graduate, eight years' experience as engineer and assistant superintendent coal, lead, silver and phosphate mines. Married. Available now. PW-206, Engineering and Mining Journal, 520 No. Michigan Ave., Chicago, Ill.

MINING engineer, graduate, age 29, desires mine operating connection. Eight years' progressive experience, miner to superintendent, States and Latin America. Now employed, but due to shutdown will be available January first. Fluent Spanish. PW-208, Engineering and Mining Journal, 520 No. Michigan Ave., Chicago, Ill.

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(Position Wanted)

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No matter where you are located you can buy from our extensive stocks with full assurance that the operating condition of the equipment delivered will be exactly as represented to you.

Write for our "Complete Stock List" of equipment GUARANTEED REBUILT and priced to save you money!

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1—6-ft.x22-in. "Eimco" Conical Ball Mill, complete with new molychrome steel liners.
1—6x16-in. Hardinge Con. Ball Mill with liners.
1—4½-ft.x16-in. Hardinge Conical Pebble Mill, belt drive.
1—7-ft.x6-ft. Allis-Chalmers Ball Mill, complete with liners and motor drive.
1—6x6-ft. Marcy Ball Mill, complete with liners.
1—64½ Marcy Ball Mill, complete with liners.
1—8-ft.x30-in. Hardinge Conical Ball Mill, complete, with liners.
1—5-ft.x5-ft. Colorado Iron Works Ball Mill, complete with liners.

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1—Model "C" Heavy Duty Duplex Classifier, size 6-ft.x20-ft.
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1—Model "C" Dorr Simplex Classifier, size 2-ft. 6-in.x14-ft. 8-in.
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1—12-Cell Minerals Separation 18-in. Sub-A Flotation Unit.
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1—Denver 6-Cell 15-in. Fahrenwald Sub-A Flotation Unit.
1—Kraut 6-Cell Flotation Unit.
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3—Janney Laboratory Flotation Test Machines.

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1—3-ft.x2-ft. Oliver Continuous Drum Type Filter, metallurgical type (acid-proof) with oscillating agitator.
1—12-ft.x6-ft. Oliver Continuous Drum Type Filter (acid-proof) bronze paddle agitator.
1—4-ft.x1 Disc American Continuous Filter complete with vacuum equipment.
1—6-ft.x3 Disc American Continuous Filter complete with vacuum equipment.
2—6-ft.x6-ft. Oliver Continuous Drum Type Filters, complete with vacuum equipment.
1—12-ft.x12-ft. Portland Continuous Drum Type Filter.

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6—2-in. Colorado Iron Works Diaphragm Pumps.
2—2-in. Dorco Diaphragm Pumps.
3—3-in. Colorado Iron Works Diaphragm Pumps.
3—4-in. Colorado Iron Works Diaphragm Pumps.
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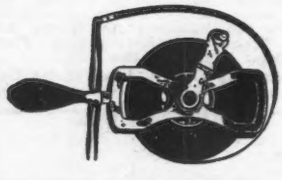

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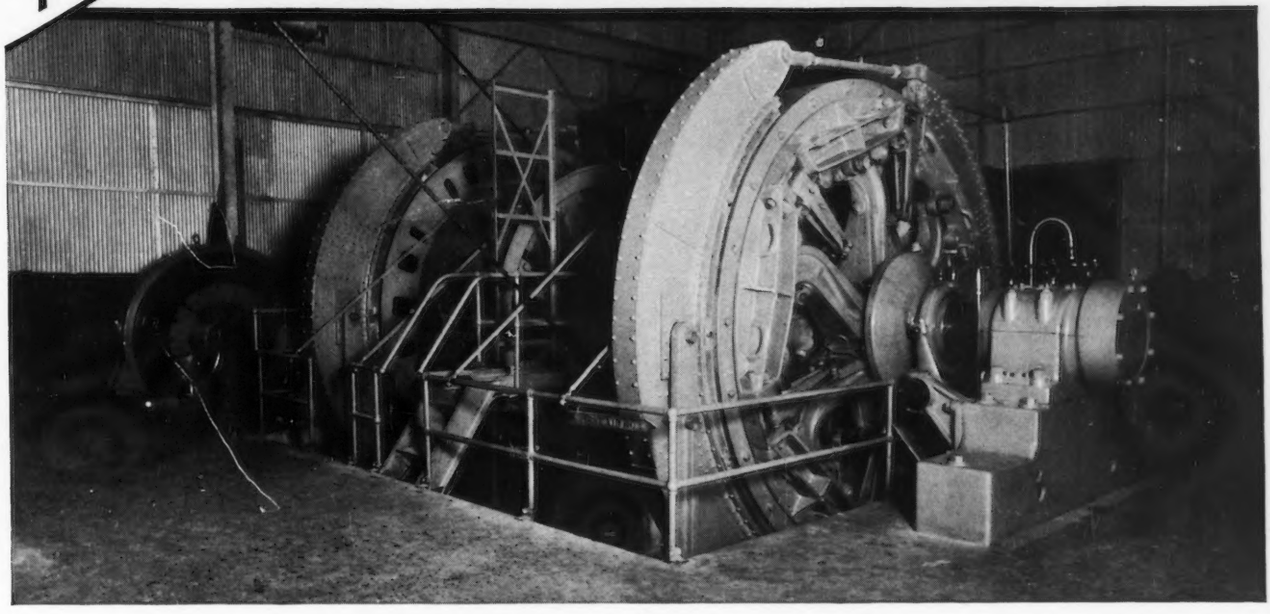

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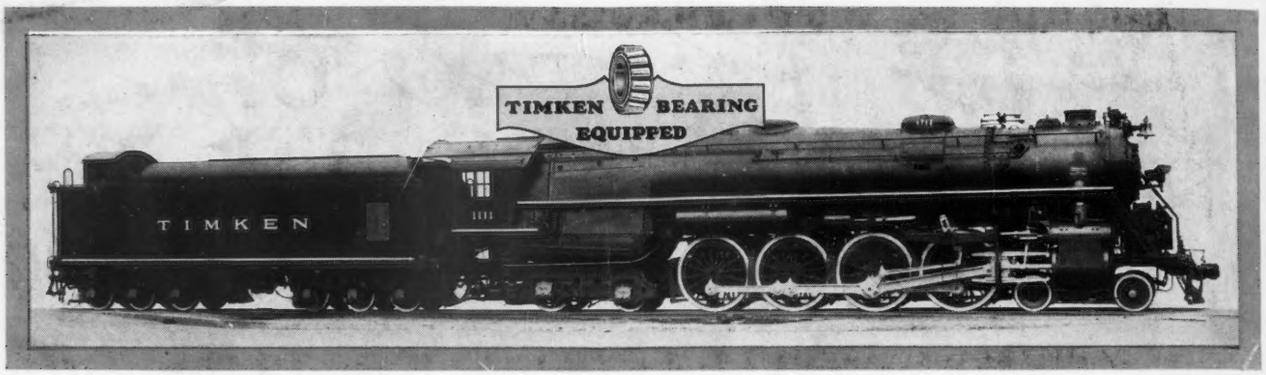

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It has been placed in service on a strictly non-revenue basis, and is being loaned without charge to railroad companies desiring to determine its operating characteristics under their own conditions.

Every wheel turns on Timken Tapered Roller Bearings—front truck wheels, driving wheels, trailer truck wheels and tender truck wheels.

There are 32 Timken bearings in the wheels and booster, and in addition Timkens are used in the speed driver of the valve pilot and in the train control governor.

Another revolutionary feature of this locomotive made possible by the higher rotative driving wheel speeds secured through the use of Timken Bearings, is the fact that it can handle fast freight and passenger trains with equal efficiency, having the necessary power and speed for both purposes.

All of the Timken benefits which users of Timken-equipped industrial machinery have enjoyed for years are reflected in the Timken locomotive, namely, friction elimination, lubrication economy, power conservation, radial, thrust and combined load capacity, extended machine life—modern anti-friction necessities that only Timken Bearings can provide. Don't you want these same enduring economies in every piece of equipment you operate? The Timken Roller Bearing Co., Canton, Ohio.

TIMKEN *Tapered Roller* **BEARINGS**